VARIETIES OF ACQUIRED PHONOLOGICAL DYSLEXIA

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SUMMARY

The existence of different varieties of the acquired reading disorder termed "phonological dyslexia" is demonstrated in this thesis. The data are interpreted in terms of an information-processing model of normal reading which postulates autonomous routes for pronouncing lexical and non-lexical items and identifies a number of separable sub-processes within both lexical and non-lexical routes. A case study approach is used and case reports on ten patients who have particular difficulty in processing non-lexical stimuli following cerebral insult are presented.

Chapters 1 and 2 describe the theoretical background to the investigation. Cognitive models of reading are examined in Chapter 1 and the theoretical status of the current taxonomy of the acquired dyslexias discussed in relation to the models. In Chapter 2 the symptoms associated with phonological dyslexia are discussed both in terms of the theoretical models and in terms of the cosistency with which they are reported to occur in clinical studies. Published cases of phonological dyslexia are reviewed.

Chapter 3 describes the tests administered and the analysis of error responses. The majority of tests require reading aloud of single lexical or non-lexical items and investigate the effect of different variables on reading performance.

Chapter 4 contains the case reports.

The final chapter summarises the different patterns of reading behaviour observed. The theoretical model predicts the selective impairment of subsystems within the phonological route. The data provide evidence of such selective impairment. It is concluded that there are different varieties of phonological dyslexia corresponding to the different loci of impairment within the phonological route. It is also concluded that the data support the hypothesis that there are two lexical routes. A further subdivision of phonological dyslexia is made on the basis of selective impairment of the direct or lexical-semantic routes.

Keywords: neuropsychology; reading; phonological dyslexia

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TABLES

FIGURES

Chapter 1

THEORETICAL ISSUES

1.1 Phonological dyslexia: a working definition

Phonological dyslexia is an acquired reading disorder in which the reading of nonwords is impaired relative to the reading of words. Visual and morphological derivational and inflectional errors may occur and function words may be read less efficiently than other parts of speech. Semantic errors are not observed.

The preceding paragraph offers a working definition of phonological dyslexia of the type which has provided a basis for classification in case reports and reviews of the acquired dyslexias (e.g. Shallice and Warrington (1980); Patterson (1981); Sartori et al (1984)). As a working definition it is adequate in that it allows the majority of patients so far observed to be labelled unequivocally but it is not helpful in determining the category to which a number of "borderline" cases should be assigned. Furthermore, the theoretical status of the term "phonological dyslexia" is unclear.

1.2 The status of the neuropsychological syndrome

The notion of neuropsychological syndromes and the practice of assigning patients to certain categories of disorder have recently received critical attention from those working within the discipline. Marshall (1982); Caramazza (1984), and Schwartz (1984), examine the use of the term "syndrome" in the study of acquired language disorders with particular reference to the validity of the classical taxonomy of the aphasias. It emerges from these discussions that there are two possible ways of using the term "syndrome". A syndrome may be defined on purely empirical grounds as a set of symptoms which reliably co-occur. There is no intrinsic theoretical relationship between symptoms (in terms of current psychological theory) and any one symptom can dissociate from any other or form part of the symptom-complex of more than one syndrome. Thus, as Coltheart (1984) points out, it is possible for patients who have different sets of symptoms to be assigned to the same diagnostic category. This is not to say that the classical taxonomy has no value in the clinical setting. Traditionally, such symptom-complexes were associated with purportedly unique anatomical lesion sites and knowledge of the set of symptoms which a patient displayed enabled predictions of lesion site to be made. Marshall (1982) notes that the classical lesion site - aphasia syndrome correlations have stood the test of time remarkably well, although a number of cases which provide evidence against the classical model may be cited (Levine and Sweet, 1982) and there are logical problems involved in this type of mapping procedure (Mehler et al., 1984). As a means of grouping patients for the purposes of research designed to identify or clarify systems involved in normal cognitive processing, the use of the syndrome in this sense (which Caramazza, 1984, calls the "weak" sense) appears to be indefensible.

An alternative use of the term "syndrome" is to make a theoretically-motivated distinction between different types of disorder. Caramazza (1984) calls this the "strong" sense of the term. In this case, the symptoms which co-occur should follow deductively from impairment to a functional subcomponent of a general skill. Ideally a symptom will appear in the context of only one syndrome and the set of symptoms associated with each syndrome may be clearly specified in terms of a theoretical model of the skill. It is only when the term is used in this strong sense, it is argued, that the use of the syndrome as a means for grouping patients for experimental purposes can be justified.

The current acquired dyslexia taxonomy is of more recent origin than the classical aphasia taxonomy and has been developed in terms of current theoretical models of the normal reading process. In spite of this, the different categories of acquired dyslexia as currently defined, do not achieve syndrome status in the strong sense of that term. Claims regarding the validity of the classification system appear to use the term syndrome in its weak sense.

Coltheart (1980) argues that, in deep dyslexia, the occurrence of a single symptom (the semantic error) guarantees the occurrence of a set of eleven further symptoms and that the putative syndrome "possesses a uniformity and homogeneity which makes it unique among neurolinguistic syndromes". However, Coltheart does not claim that the co-occurrence of the twelve symptoms of deep dyslexia is theoretically necessary and acknowledges that a number of the symptoms occur in the context of reading disorders other than deep dyslexia.

A similar criticism of phonological dyslexia can be made. Sartori et al., (1984) claim that "a given set of symptoms is always observed, but each individual symptom may also form part of other syndromes."

In fact, with so few fully-reported cases of phonological dyslexia available in the literature, it is not yet posssible to identify a set of symptoms which co-occur with statistical reliability.

Before discussing further the validity of regarding phonological dyslexia as a specific syndrome or variety of acquired reading disorder, I shall turn to a consideration of the models with which it is associated in order that reference may be made to specific subcomponents of the models in illustrating the extent to which the classification system is theoretically motivated.

1.3 Cognitive models of reading

1.3.1 Dual and triple route models

1.3.1.1 The independence of routes

In 1973, Marshall and Newcombe published a paper which had enormous influence on the interpretation of acquired dyslexic disorders. They identified three types of reading impairment and interpreted these in terms of a two-route model of the reading process (see Fig. 1.1). According to this model, the graphemic representation once having accessed a "primary visual register" could be matched directly with a stored semantic entry or could be translated into a phonological code which could be output as it stood or could in turn access a semantic entry.

The proposed model related to a question which was receiving a considerable amount of attention in the 1970's, that of the role of phonological coding in lexical access. On the basis of experimental evidence (most commonly obtained from lexical decision or semantic categorization tasks using homophones or pseudohomophones), a number of models were developed which proposed that phonological recoding must precede lexical access (e.g. Rubinstein et al., 1971; Gough, 1972; Smith and Spoehr, 1974; Gough and Cosky, 1977. Alternative models were based on contradictory evidence which suggested that lexical access could be achieved on the basis of a visual code without phonological mediation (e.g. Bower, 1970; Kolers, 1970; Smith, 1971).

Four of Marshall and Newcombe's patients exemplifying two types of impairment neatly illustrate the effects of failure of either of the two routes, the consequent reliance on the remaining route supporting the claim that the routes are independent and capable of operating in isolation (although not necessarily in an error-free fashion).

The notion of availability of alternative access codes was explicated by Meyer et al., (1974). Further supporting evidence was obtained by Davelaar et al., (1978) and later by Andrews, (1982), who showed that subjects were able to switch to the strategy best suited to a particular task.[1] Evidence for necessary pre-lexical phonological recoding has been reviewed by Coltheart (1978) and Coltheart (1980a). Coltheart shows that the experimental tasks used in studies of lexical access do not in fact require pre-lexical phonology but can be performed using direct visual access or post-lexical phonology and argues convincingly for the availability of both routes to the normal reader (see Fig. 1.2 for the model proposed by Coltheart, 1980a).

The issue is not fully resolved and continues to be investigated experimentally, (e.g. Besner et al., 1981; Underwood and Thwaites, 1982; Rossmeissl and Theios, 1982). Evidence for and against pre-lexical phonological coding continues to be found but can be explained in terms of task demands. Underwood and Thwaites' task, for example, clearly elicited semantic processing prior to lexical decision and phonology may also have been obtained post-semantically. There appears to be no reason to question Coltheart's conclusions regarding the availability of two routes.

The possibility of an additional route[2] in which output phonology is directly linked with the visual representation evoked by the graphemic input has been discussed in connection with the condition known as hyperlexia. Hyperlexic children are able to read aloud efficiently in the absence of comprehension (e.g. Baron, 1977).

Evidence (though not conclusive evidence) for this additional route has been provided by neuropsychological studies. Schwartz et al., (1980) note that a demented patient was able to read aloud irregular words (for which assembled phonology would produce erroneous responses) which she was unable to comprehend. It is, however, possible that there was a degree of semantic mediation in this case (Howard, 1985). Coltheart et al., (1983) and Funnell, (1983) describe further relevant cases. Coltheart et al.'s acquired and developmental surface dyslexic patients were able to read aloud some irregular words but on many occasions defined the homophone of the word when asked to explain its meaning. Funnell's patient was unable to assemble phonology but was extremely efficient at word-reading and made very few semantic errors in spite of an inability to distinguish between pairs of meaning-related words in a comprehension task.

These types of 3-route model (Figs. 1.3, 1.4, and 1.5 show examples) will henceforth be termed "standard models".

A revised version of the logogen model (Morton and Patterson, 1980a) developed by Morton (e.g. Morton, 1969; Morton, 1970; Morton, 1979 includes this direct link between input and output systems (Fig. 1.3) and an additional "grapheme-phoneme conversion route (for dealing with non-lexical phonology) not included in early models. The logogen model has been highly influential in the development of information-processing models of reading. Henderson (1982) comments on the "adoption of 'logogen language' as a sort of metalanguage" and indeed, Ellis (1982) used the concept of the logogen in developing an elaborate model which includes routes by which spelling and writing may be achieved in addition to indicating the stages involved in reading, speaking and hearing (Fig.1.4). There is a disadvantage in building models around the concept of the logogen which has been noted by Morton himself (Morton, 1980) when expanding the model to take account of writing and spelling. This is that the logogens (evidence collectors with thresholds) either "fire" (i.e. output an abstract code) or do not fire. There is no possibility of the transmission of an incomplete code and hence the partial word specific orthographic knowledge displayed by one of Morton's patients is hard to account for in logogen terms. Since most current models incorporate aspects of the logogen model which recommended it in preference to other models

Fig.I.I A dual-route model of the reading process

Marshall and Newcombe (I973), pI89

Fig.I.2 A dual-route model of the reading process

Coltheart (I980a) , p202

Fig.I.3 A three-route model of the reading process

Morton and Patterson (I980a) p95

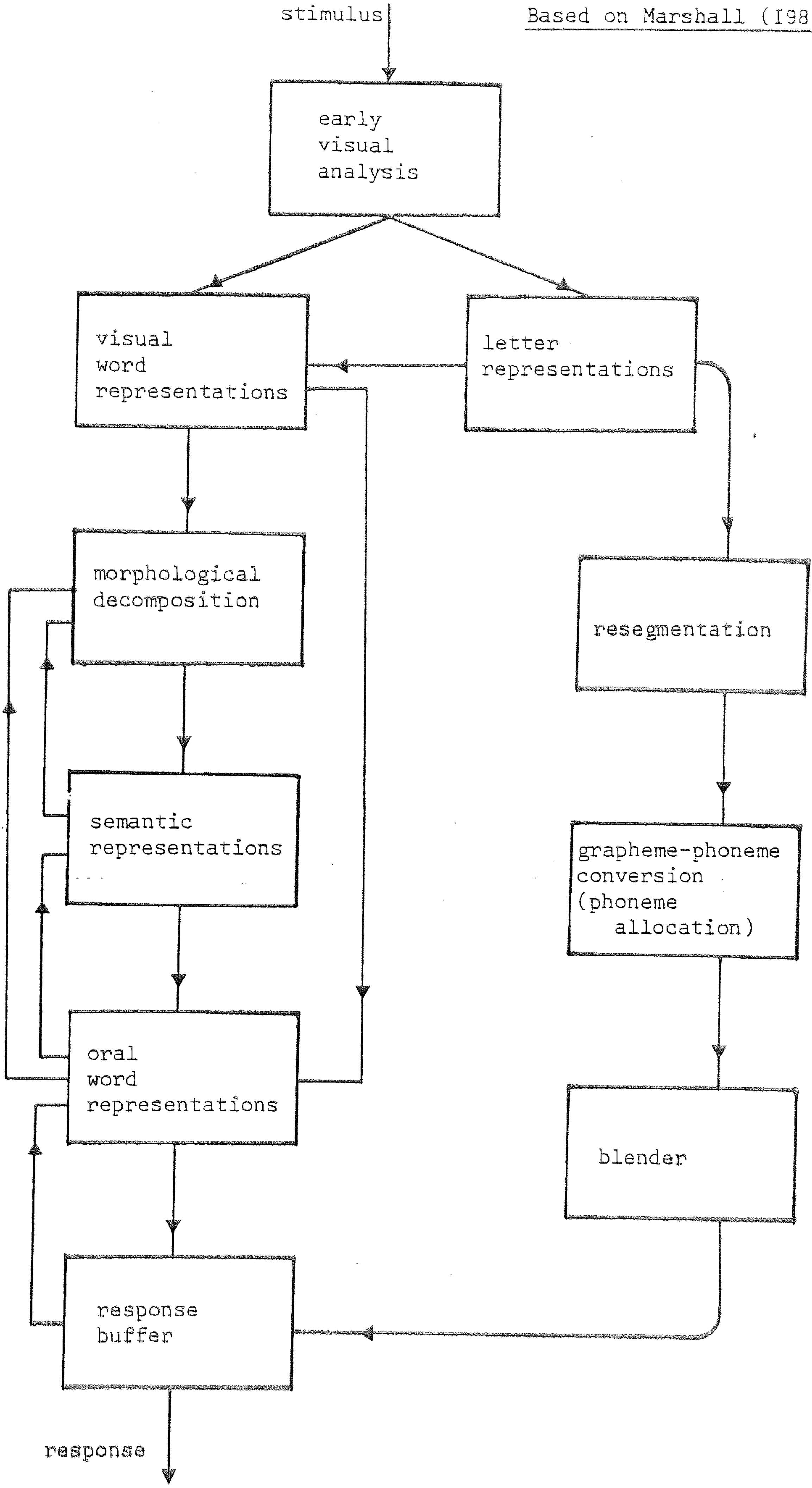
buffer

Fig.I.4 A three-route model of the reading process

(and other language processes) Ellis (I982) pI40

acoustic code: all. = allographic code: g.m.p. = graphic motor pattern code: gr. = grapheme code: kin. = kinaesthetic code: l. = lexical code: ph. = phonemic code: p. = semantic code: vis. = visual code

Based on Marshall (1985)



process. Simplified from Shallice (I98Ia) pI88

Fig.I.7 A 'lexical pooling' model of the reading

process. Marcel (I980) p242

available in the sixties and early seventies (the existence of a separate semantic system and of a direct link between the visual input system and semantics without phonological mediation) there now seems to be no advantage in talking in terms of "logogens" in preference to the less specific "abstract word representations".

1.3.1.2 Components of the standard model

1.3.1.2.1 The morphological decomposition system

A recent model (Fig. 1.5) proposed by Marshall (1985) has the advantage of specifying in more detail than in preceding models, the subsystems which may operate within the phonological route. It also proposes an additional operation within the lexical-semantic route, that of morphological decomposition. The morphological decomposition system follows the visual word recognition system in this model. A number of studies noted in the following discussion address the issue of whether morphological decomposition precedes or follows word recognition. In terms of Marshall's (1985) model, the issue is whether the visual recognition system is a word or morpheme-based system. The issue is complicated by the fact that there are a number of logical possibilities concerning the presence and order of these operations. Morphological decomposition may not occur at any stage. If it does occur, recognition of morphemes may precede or follow word recognition or may take the place of word recognition so that morphemes access semantic or phonological representations. A further possibility is that both words and morphemes assess semantics and output phonology. The following discussion is confined to consideration of possibilities which have been proposed in the published literature and which can be assimilated to published versions of the standard model. The issue resolves into that of whether the initial visual recognition system is word-based (the output from this system entering a morphological decomposition system) or whether the initial visual recognition system is morpheme-based.

Work by Bradley (1980) and Taft (1981) is cited by Marshall in connection with the inclusion of the morphological decomposition component. It should be noted that Taft's (1981) work is based on a specific class of derived words, namely prefixed words and though Taft and Forster (1975), presenting their original model of word retrieval, assumed that inflected words would be processed in the same way, it seems possible that different processes might be involved since the prefixed and the inflected words stand in slightly different semantic and syntactic relations to their base morphemes. In fact, there is evidence that the parsing of inflections occurs postlexically (Smith and Groat, 1979; Henderson et al., 1983) while the parsing of prefixes occurs prelexically (Smith and Sterling, 1982). In reviewing studies on morphemic parsing, Smith et al. (1984) suggest that prelexical parsing is a rudimentary operation which enables the reader to pick out potentially useful letter strings while postlexical parsing facilitates comprehension and pronunciation.

More recent experimental work by Taft (1984), using a homophome judgment task, provides very strong support for the claim that lexical representation takes the form: stem plus affix. Subjects were far less efficient at judging whether or not a word was a homophone if the word with which it was homophonous differed in morphophonemic structure (e.g. cowered/coward) when prior pronunciation of the words was prohibited. This task, however, requires processing of stimuli to the output wordrepresentationstage and the results are not therefore relevant to the issue of whether the visual representation system (i.e. the input system) is morpheme-based. Taft's results are compatible with the notion of post-lexical (in the sense of post-semantic or post-visual word recognition) parsing.

Bradley (1980) used suffixed items of the form #ness, #er, #ment and #tion in a lexical decision task. She found that, with the exception of the final category of items, it was the frequency of the base morpheme as it occurred in all inflected and derived forms which affected reaction time rather than the frequency of a specific devised form. This finding strongly supports the notion of a morpheme-based system although it appears that items of the form #tion must be represented differently in the lexicon since neither type of frequency count predicted reaction times for these items. Since lexical decision may be carried out using the whole-word recognition system only, Bradley's findings may be interpreted as suggesting that this system is itself morpheme-based and that morphological decomposition occurs prior to whole-word recognition. On the other hand, there is some evidence that the semantic system is normally involved in the lexical decision task (James 1975; Warrington 1975). Interpretation of results is complicated by the fact that there may be alternative strategies available for performing the lexical decision task.

The results of experimental investigation carried out in connection with the logogen model (Murrell and Morton, 1974) in which word recognition was facilitated by prior presentation of a word sharing the same base morpheme but not by a different morpheme of equal visual similarity suggest that the visual input-logogen system is morpheme-based. If the input-logogen system is equated with Marshall's word recognition system, these results also suggest that the additional component is unnecessary, since morphological decomposition occurs after word recognition in Marshall's model.

An alternative theory which proposes that each derived form of a word has an independent entry and that morphological decomposition does not occur at any stage during lexical access (the single unit hypothesis) has been tested by Manelis and Tharp (1977). They used a lexical decision task in which two items were presented simultaneously for judgment. Subjects were asked to make a positive response only if both items were words. Real word items were either suffixed (e.g. sender) or pseudo-suffixed (e.g. sister). There was no significant difference in the time taken to judge suffixed and pseudo-suffixed pairs and Manelis and Tharp argue that their results support the single-unit hypothesis. However, subjects' response latencies were increased when a "mixed pair" (one affixed and one pseudo-affixed word) was presented. This result poses a problem for the single unit hypothesis. A second experiment carried out by Manelis and Tharp required subjects to judge whether a particular stimulus word was contained in an affixed word or nonword which followed it (e.g. was <u>snow</u> contained in <u>snowed</u>, <u>slowed</u>, <u>snowen</u> or <u>slowen</u>). Subjects responded faster when the second item was a real word. This does suggest that the test items did not undergo decomposition although, as

Job and Sartori (1984) point out, their experimental materials have been criticised on the grounds that the affixes for words and nonwords were not matched for frequency.

In fact, even if Manelis and Tharp's own interpretation of their results is accepted, this does not necessitate the rejection of a decomposition hypothesis. If we assume that lexical decisions can be made, under certain conditions, without reference to the semantic system, then these results are compatible with the notion that the morphological decomposition system operates on the output of the visual word recognition system as proposed by Marshall (1985).

Neuropsychological evidence relevant to the issue of the stage at which morphological decomposition takes place is somewhat scanty and difficult to interpret although it clearly adds weight to the conclusion indicated by evidence from normal readers that base morphemes and affixes are handled separately at <u>some</u> stage of the reading process. Patterson (1980) reports a number of lexical decision experiments with deep dyslexics but concludes only that these experiments are compatible with the assumption that morphological parsing precedes word recognition and do not provide conclusive evidence. The acquired phonological dyslexic AM (Patterson, 1982) showed reduced accuracy on a lexical decision task containing affixed words. This suggests a morpheme based visual recognition system but in AM's case there is no evidence that the lexical-semantic system is impaired and therefore this effect may be explained in terms of semantic involvement in lexical decision. If semantics are accessed in this task, morphological decomposition will precede lexical decision whether it occurs before or after visual recognition.

The occurrence of derivational errors in the reading responses of dyslexic patients who are relying on the lexical-semantic route is also consistent with pre- or post-recognition parsing since base and affix would have been separated before output phonology is obtained in either case. Of considerable interest here is the patient WB (Funnell, 1983) who, showing evidence of impairment to the lexical-semantic route, and unable to assemble phonology, relies on the direct route (which links visual recognition and output word representation systems) to obtain lexical phonology. WB showed no effect of the presence of a suffix in reading lists of words. He was, however, unable to read suffixes presented in isolation which were apparently treated simply as nonsense syllables. This evidence contradicts much of the evidence already presented which tends to support the notion of a morpheme-based visual recognition system. It provides strong support for the assumption that the system is word-based and contains no independent entries for affixes.

The issue cannot be resolved on the basis of evidence currently available. Experimental investigation, possibly using a priming task similar to that used by Murrell and Morton (1974) with dyslexic subjects like WB would be helpful. At present, the evidence for prelexical morphological decomposition is not weighty enough to force the substitution of a morphemic recognition system for the visual word recognition system since much of this evidence could also support the hypothesis that morphological decomposition follows visual word recognition. The order of stages in the model proposed by Marshall

(1985) will therefore be retained in the absence of firm evidence to the contrary.

A more general issue regarding the conceptual status of base morphemes and affixes should be mentioned here. The reason usually advanced in explanation of the presence of a morphological decomposition system is one of storage economy within the lexicon. Numerous derived forms of a word may, if such a system is present, be covered by a single lexical entry (e.g. Taft and Forster, 1975). The concepts of transformational grammar (Chomsky, 1957; Chomsky, 1965) have also been brought to bear on discussions of morphological decomposition (e.g. Smith et al., 1984). Now the relationship between the root form and the actual phonological form which a given word takes following morphophonemic transformation (Chomsky, 1959) or the application of phonological readjustment rules (Chomsky and Hallé, 1968) is of no essential significance according to the theory of transformational grammar. The relationship between the right and left-hand entries in the morphophonemic rewrite rules "take + past → / tʊk /" and "go + past → / wɛnt /" is no different from that between the entries in "arrive + past → / ɑraɪvd /" and "jump + past → / dʒʌmpt /". Orthographic or phonological similarity is irrelevant at this level.

If this is the conceptualisation of the relationship between abstract and output forms that underlies accounts of morphological decomposition then the position of Job and Sartori (1984) regarding the regular and irregular forms of Italian verbs (the former share an orthographically similar root morpheme with the infinitive form, the latter do not) must reflect an alternative conceptualisation of the decomposition process. Job and Sartori assume that "only regular forms of irregular verbs can be productively stored as root morpheme plus affix". This account appears inconsistent in that it maintains that the basis for the stripping of affixes is not a matter of visual similarity (if it were affixes would also be stripped from "pseudo-affixed words) yet denies a relationship between inflected forms which do not resemble one another visually. It will be assumed for the purposes of this work that all inflected forms of a morpheme are related in by rule regardless of the extent to which they resemble one another visually. It is nevertheless recognised that there is some difficulty in reconciling this view with the notion of a morpheme-based word recognition system since it implies some knowledge of the syntactic relatedness of different forms which one would expect to be stored within the cognitive system and to be outside the scope of a visual word recognition system.

1.3.1.2.2 Subsystems within the phonological route

The additional subsystems in the phonological route are proposed on the basis of logical analysis although some relevant empirical data can be found. The justification for the inclusion of each subsystem will be discussed individually.

1.3.1.2.2.1 Letter recognition

Whether letter recognition <u>necessarily</u> precedes word recognition is debatable. Experimental studies with normal subjects which suggest that word recognition does not depend on prior encoding of component letters of the word have been reviewed by Adams (1979). The results of Adams' own work using typographic irregularity, like findings presented by McClelland (1976) whose experiments utilised mixed case displays, are consistent with the hypothesis that there is preliminary letter identification in the recognition of words and nonwords. Evidence from an acquired dyslexic patient (Warrington and Shallice, 1979) may be interpreted as indicating that word recognition can proceed without preliminary letter identification but alternative interpretations are possible (see Besner et al., 1984 for discussion). This is a separate issue, however, from that concerning letter identification as a stage in assembling phonology via the non-lexical route. Evidence which suggests that letters input visually are matched with abstract letter representations which are not case-specific has been presented by Coltheart (1981a), (and discussed by Besner et al., 1984) who found that a patient who could not convert graphemes into phonemes was nevertheless able to decide whether pairs of nonword letter strings presented in different case were composed of the same letters. Individual letter recognition may be optional in word reading but is surely a necessary stage in nonword reading since the abstract letter representations thus obtained are the input into the resegmentation system.

1.3.1.2.2.2 Resegmentation

Colheart (1978) and Coltheart et al., (1979) point out that the knowledge of grapheme-phoneme correspondences required by a speaker of English is quite complex in that the relationship of letters to phonemes is not always one-to-one. Digraphs are frequent in English spelling patterns and combinations of more than two letters sometimes occur. Coltheart et al., suggest that a parsing operation (henceforth termed "resegmentation" in order to avoid confusion with the morphemic parsing operation discussed earlier) must be performed in order to identify graphemic units corresponding to a single phoneme to which an appropriate phoneme can then be assigned. The term "grapheme" has been employed by many authors, e.g. Coltheart (1984), to denote the unit identified by the parsing process (see Henderson, in press, for a full discussion of the different applications of the term). "Grapheme" has also been used to describe the "minimal distinctive unit of a writing system" and the "abstract letter identity in all its physical manifestations". I shall use the term in the first sense described (as "a letter or cluster of letters that stands in correspondence with a phoneme") for the sake of convenience since some term is required to describe the output of the parsing system. I do so, however, with reservations since i) as Henderson points out, there are certain letters where there is a one-to-many mapping between letter and phonology, e.g. x →/ks/ and these seem to require a separate descriptive term under this definition and ii) it is possible that the digraph is perceived as a unit. This latter possibility is suggested by a trend observed in data from an orthographic resegmentation task[3] collected by Patterson and Marcel (personal communication). The data suggest that some patients have more difficulty in identifying a series of letters in a letter string which, when inserted into a gap in an accompanying letter string, make it a word when the task requires them to isolate an "unnatural" graphemic segment which does not correspond to a single phoneme (e.g. ot) than when a "natural" graphemic segment corresponding to a single phoneme (e.g. th) must be isolated. If this trend turns out to be a reliable effect, it may present problems for the notion of the resegmentation system since there seems to be no way of explaining the difficulty without assuming that the digraph is perceived as a unit at an early stage of analysis unless the phenomenon is the result of an inability to suppress the graphemic parsing operation. Thus an alternative to postulating a resegmentation system is to assume that the English alphabet contains considerably more than 26 symbols, each combination of letters, as well as single letters, being individually represented. This seems plausible. There are only a limited number of features which combine in different ways in order to represent letters. They do not usually represent letters when standing alone, but there are exceptions - "d" (c + l) and "w" (v + v). Nor are they usually physically separate but again there are exceptions (the dots on lower-case "i" and "j"). On the basis of this incomplete data, there is no reason to reject the notion of an independent resegmentation system. The alternative does, however, merit recognition as a logical possibility in the absence of reliable disconfirming evidence.

It is possible to make a distinction between two types of resegmentation operation which appear to be necessary in dealing with English spelling patterns. The first may be described as simple sequential resegmentation and involves the identification of sequences of letters forming letter combinations corresponding to a phoneme as in (to use Coltheart's, 1984, example) sherry → / ʃɛri /. The second is involved in the processing of final "e" when it performs (as it does in the majority of words now used in the English language e.g.

case) a marking function. Here the preceding vowel must be paired with a letter which is separated from it by an intervening letter or letters. Rudimentary positional information must be recorded in order to identify the "e" as "final e". The operation cannot be carried out by means of a simple left-to-right parse. Henderson (1982) notes both types of constraint on letter-sound translation and additionally a third constraint in which a letter is phonemically realised in addition to performing a marking function (e.g. the "e" in cent). Letter sequences constrained in this way are unlikely to be dealt with by the resegmentation system, however, since, as defined, this system identifies units which correspond to single phonemes. It seems more likely that marking information would be utilised as part of a selection procedure at the stage of Phoneme Allocation.

Some empirical evidence for the existence of this system is offered by Dérouesné and Beauvois (1979) who show that two of the four acquired dyslexics with impaired nonword reading whom they tested, found "graphemically-complex" nonwords, which are in effect nonwords containing a vowel digraph, significantly more difficult to read aloud than words in which letter-sound correspondences were one-to-one. In fact all four patients showed a trend towards reading this type of nonword less efficiently although the difference between scores on the different stimulus types did not reach significance for the remaining two patients. More recently, Dérouesné and Beauvois (1985) report an effect of "graphemic complexity" on the reading performance of LB, a further patient who showed impaired nonword reading.

1.3.1.2.2.3 Phoneme Allocation

Grapheme-phoneme mapping remains a complex process even after resegmentation has been performed since certain graphemes may be realised by more than one phoneme (Haas, 1970; Venezky, 1970; Wijk, 1966). The grapheme ea for example may be matched with i,/ ε /, or / εı/. Accounts of the operation of the phonological route normally assume that a single phoneme is made available for each grapheme and that this is the "regular" (Coltheart et al., 1983) or "most frequent" (Marshall, 1985) correspondence. If this is the case, the only error of nonword reading which could occur at this stage would be one of gross and random mis-matching, for instance, pairing the grapheme b with the phoneme /m/. In word reading which depended on this route, the "regularisation error" would occur as in the much-quoted example from the error corpus of the surface dyslexic JC (Marshall and Newcombe, 1973) broad →/ broɷd /. If patients like JC make errors which involve the use of "irregular" but nevertheless possible correspondences, it must be assumed that the phonological route operated defectively on this occasion (Henderson, 1982). Shallice et al., (1983) analysed grapheme-phoneme correspondence errors made by such a patient in terms of the occurrence of correspondences which are "regular", "alternative" (in which the correspondence is as frequent in English words as the regular correspondence), "unusual" (in which the correspondence occurs in English words but may be regarded as divergent), "exception" (in which the correspondence occurs in less than twenty English words) and "wrong" (the correspondence never occurs in English words). The criteria are based on the analysis of English spelling by Wijk (1966). Although regularisation errors on exception words accounted for the largest proportion of errors, all other error types were observed. A number of alternative pronunciations of regularly-spelled words are recorded (e.g. <u>shadow</u> → / ʃeɪdoʊ /. Shallice et al. offer an alternative explanation of their patient's reading errors which will be discussed later. If an account is given in terms of a standard model, it must be accepted that knowledge of minor correspondences (Venezky's, 1970, terminology) is contained within the phonological route as well as knowledge of major correspondences.

If knowledge of individual grapheme-phoneme matchings is built up from experience with words of the language, it seems unlikely that no record of alternative realisations would be kept. It seems more plausible that a selection of weighted entries are elicited by an ambiguous grapheme with the "regular" or "most frequent" being most readily available. It is in fact extremely difficult to make claims about the frequency of occurrence of alternative phonemic realisations. Simply recording the number of words of the language containing one or other alternative may be misleading, especially as irregular words tend to be of higher frequency than regular words (Henderson, 1982) so that the number of times an irregular correspondence is actually produced may be much higher than would be expected on the basis of a count of the number of words in which it occurs.

On the other hand, normal readers do appear to have explicit knowledge about the status of grapheme-phoneme correspondences as regular or exceptional. Barber and Millar (1982) asked subjects to choose the "typical English pronunciation" of a grapheme or segment which was pronounced differently in different words. They chose the "regular" pronunciation (as defined by Wijk, 1966 and Venezky, 1970) far more often than the alternative pronunciation, regardless of the frequency of the words in which they appeared. For example in the pair wave-have the segment ave was considered typical when pronounced "/eɪv/", in spite of the fact that "wave" is a word of much lower frequency than "have".

A further consideration is that if units larger than the grapheme are considered, the most frequent pronunciation of the segment may differ from both the most frequent and the regular pronunciation of the grapheme. Thus the regular pronunciation of oo is /u/ and corresponds with the most frequent realisation of the segment ool (/ul/ as in "fool", "pool", "cool") but conflicts with the most frequent realisation of ook as / ʊk / (as in "book", "cook", "look" for example). Patterson and Morton (1985) suggest that these higher-order units have entries in the grapheme-phoneme correspondence system within an independent phonological route. Such a model with this type of extended stores of correspondences will be referred to as a "modified standard model" (as it is termed by Patterson and Morton (1985)).

The size-range of segments which might be stored within this extended store of correspondences is not specified by Morton and Patterson (1985). It is, however, stated that syllabic segments of the type proposed by Glushko (1979) would be present (e.g. ave). If morpheme-sized segments were to appear in this store (as they do in Shallice and Warrington's (1980) store of visual word forms) then the independent existence of the direct route might be called into question. However there is, at this stage, no suggestion that segments of more than 3-4 letters are available within this system. It would seem that segments corresponding to short words (e.g. age) would be present in the store. Thus although this account retains the independence of the phonological route, it does require revision of the assumption that the route is in every sense non-lexical.

For the purpose of this work, the notion of single grapheme-to-phoneme conversions is retained and the Phoneme Allocation system is conceptualised as operating on graphemic units. The system does not contain segments larger than the grapheme. However, it is proposed that alternative phonemic realisations for inconsistent graphemes are stored within the system. When an inconsistent grapheme (e.g. ea) accesses the Phoneme Allocation System all possible phonemes which legitimately map onto the grapheme are activated. In the case of the grapheme ea, the phonemes /i/, /ɛ/,and /ɛɩ/ will become available. A single phoneme is then selected from the range of activated phonemes. The "regular" correspondence may tend to be chosen by normal readers as phonemes and may be differentially weighted. This account of the Phoneme Allocation System is compatible with the evidence relating to nonword reading discussed in this chapter (see, especially, Section 1.3.2.3). It has the advantage of retaining the autonomy of the phonological route while predicting that inconsistency of graphemes (though not of lexical segments) will affect reading performance. It is also compatible with the logical conclusion that, if knowledge of individual grapheme-phoneme matchings is built up from experience with words of the language, a record will be kept of alternative phonemic realisations.

1.3.1.2.1.4 **Blending**

Once a phoneme has been allocated to each graphemic unit, the string of phonemes output from the phoneme assignment system must be blended into a single unit. If phonemes are output serially from the phoneme allocation system is seems likely that they are held in a buffer store before being fed in parallel into the blender.

It has been assumed that the phonemes allocated during phoneme assignment are of syllabic structure corresponding to that output in response to a single letter presented in isolation. Thus Baddeley (1970) commenting on the difficulty of obtaining a blended whole from a string of isolated phonemes, explains the difficulty thus: "Take a very simple word like "mad"; if the child simply reads off the sound made by each individual letter, he is likely to come up with some sounding like "muh", "a", "duh", which strung together sound something like "muhaduh".

Funnell (1983) reports that a patient (FL) who was able to read nonwords reasonably well was quite unable to give individual letter sounds. Funnell concludes that this dissociation indicates that "non-lexical correspondence rules act upon syllables as well as graphemes". Since her patient was able to read nonwords containing letter combinations which do not occur in English (enabling Funnell to discuss the possibility of a lexical strategy for nonword reading), this statement seems to imply the existence of a store of all possible syllables, a system which is uneconomical to say the least. It seems more plausible to explain the dissociation in terms of separate stores. Phonemes in pure form are allocated to graphemes in the process of assembling phonology for an unfamiliar letter string. The phoneme allocation system was wholly or largely unimpaired in this patient. A separate store of syllabic sounds corresponding to individual letters, however, had been destroyed or become inaccessible. In this case, the loss of the ability to respond to single letters with a syllabic sound may be regarded as a particular type of anomia. This alternative interpretation obviates the need for an additional operation deleting the unrounded vowel (known as schwa) from each consonantal realisation.

It is probable that even with the additional subsystems proposed by Marshall (1984), the model is oversimplified. A certain amount of contextual information may be contained within the phoneme allocation system as suggested earlier, but Henderson (1982) has pointed out that there is an enormous amount of linguistic knowledge available to the reader and not all such knowledge has been discussed in relation to cognitive models of this type. Henderson (1982) notes that morphological knowledge could aid pronunciation of compound words like "shepherd" in which two letters which usually correspond to a single grapheme must be translated separately. In terms of the 3-route model, once an entry for a word has been established in the whole-word representation systems of the lexical and direct routes, the word can be read without the involvement of the phonological route. Even if the word were unknown, the morphological knowledge stored in the direct or lexical routes could not be used in the process of sub-lexical grapheme-phoneme conversion since the phonological route operates quite independently of these routes. A rather problematic finding for the standard model is that of Campbell and Besner (1981). They used nonwords substituted for words in passages of text and found that subjects tended to convert the grapheme "th" to the voiced /ð/ sound when the nonword was in a function word position but to the unvoiced /θ/ sound when it was in the position of a noun or included in a list of nonwords. They conclude that nonword reading is not entirely independent of lexical/syntactic influences.

The assignment of stress must be carried out within the phonological route since nonwords longer than one syllable can be read. Chomsky and Hallé (1968) formulated a set of rules for stress assignment. The psychological reality of these rules was investigated by Baker and Smith (1976) who showed that phonetic, morphological and syntactic properties of a nonword influenced stress assignment, although the precise formulation of the rules appeared to differ in some measure from those set out by Chomsky and Halle.

Etymological knowledge has been shown to influence pronunciation of nonwords. Smith and Baker (1976) found that the perceived origin (Romance or Germanic) of the nonword affected the realisation of final "e".

1.3.2 Models in which lexical and non-lexical procedures are not distinct

A defining feature of the standard models is the independence of the phonological route which does not have access to any word-specific information, either semantic or phonological. Two alternative types of model in which this route is not entirely independent have been proposed.

1.3.2.1 The multi-level mapping model

The first is due to Shallice and his co-workers (Shallice and Warrington, 1980; Shallice, 1981a; Shallice et al., 1983), (Fig. 1.6). Shallice et al., do in fact postulate a separate nonlexical procedure but the first stage of analysis - the visual word system - is common to lexical and nonlexical routes. The visual word form system contains a store of correspondences of varying sizes. Print to sound mapping may take place at the level of the grapheme, the consonant cluster, the sub-syllabic unit, the syllable and the morpheme, the only constraint on unit of translation being that it must occur in an English word in order to be present in the visual word form system. Segments are not necessarily units which can be defined linguistically. Both letter strings which form a word and nonword strings are fed into this system and units of different sizes are identified and translated into phonological form. Alternative phonemic realisations for graphemes are contained within the system, each alternative being normally "of a different strength".

Phonological translation based on large units (i.e. morphemes) takes place more rapidly than that based on a number of smaller units. The phonology thus obtained may then be output forthwith or may be used to access the semantic system. Thus the ability to obtain word-specific phonology without semantic mediation is accounted for within a 2-route model. Phonology does not necessarily precede access to the semantic lexicon, the latter can be achieved via an orthographic code.

The reading errors made by a patient who was unable to access semantics and was affected by the degree of irregularity of words so that words containing a single divergent but not exceptional correspondence (e.g. <u>smoulder</u>) were read better than those in which the entire morpheme was exceptional (e.g. <u>colonel</u>) provide evidence for the model when supported by an additional assumption regarding the units of translation. This assumption is that larger units are more susceptible to decay if the system is impaired than are smaller units. An explanation of this particular pattern of reading behaviour is difficult to provide in terms of a standard model unless the existence of an extended store of translation units of the type proposed by Patterson and Morton (1985) is accepted. In this case as noted earlier, the production of minor correspondences by this patient can be explained in terms of the storage of alternative realisations for ambiguous graphemes within the phonological route.

A serious problem for this model is posed by neuropsychological evidence which suggests that whole-word phonology can be retrieved without semantic mediation when the ability to assemble phonology has been lost as evidenced by an inability to read nonwords (Funnell, 1983). This problem is discussed by Saffran (1985) who states the difficulty thus: "there would seem to be no principled argument for the retention of word-level units in this (visual-word form) system at the same time that sub-morphemic units are lost; in fact, Shallice et al., (1983) argue that just the opposite (preservation of smaller units) results from impairment to this system in semantic dyslexia."

The second type of model does not include a nonlexical route but proposes that nonwords are read by analogy with real words. Such a model has been proposed by Marcel (1980), (Fig. 1.7). On Marcel's account, the letter string is segmented into orthographic units of varying sizes and these units activate matching units which appear in an equivalent position in known words. The matching process occurs within an "aural-oral" lexicon which operates on words and nonwords. As with Shallice's model, letter strings which are words are matched with morpheme-sized phonological segments but phonology for letter strings forming nonwords must be assembled from sub-lexical phonological units.

A similar "lexical pooling" model, in which decisions about the pronunciation of nonwords are made on the basis of the pronunciation of segments as they occur in words is described by Henderson (1982).

1.3.2.3 **Lexical analogy versus independent route models: a survey of the evidence**

The development of both lexical analogy accounts[4] has been influenced by the work of Glushko (1979). Glushko's paper forces reconsideration of the notions of irregularity and of the form or even existence of grapheme-phoneme conversion as a result of his finding that inconsistent words (words which contain an orthographic segment which may be pronounced differently in different words) have a longer pronunciation latency than consistent words and that nonwords containing such segments also have longer latencies. The real word effect casts doubt on the existence of direct visual to semantic or visual to oral word representation links[5]; the nonword effect seems to indicate lexical involvement in nonword reading. Glushko concludes that "words and pseudowords are pronounced using similar kinds of knowledge" and that "the difference between the pronunciation of words and pseudowords is only quantitative". On this account, words are pronounced faster than nonwords because they can be matched with a larger phorological unit; phonology for nonwords must be obtained by a process of synthesising smaller phonological units.

Glushko accounted for the longer pronunciation latencies associated with inconsistent words in terms of the activation of conflicting information about phonemic correspondences which delays output. This account is shaken by Parkin's (1984) consideration of "mildly inconsistent words" which he defines as "those (words) which possess a minor correspondence at the GPC level but that can be considered regular if one considers a higher order rule (e.g. health) and words... that are based on a letter pattern that is commonly pronounced in more than one way, with the constraint that the pronunciation carried by the word is one that contains a minor correspondence ...(e.g.glove)". A large proportion (84%) of Parkin's "mildly inconsistent words" were inconsistent according to Glushko's definition, in that they had visual neighbours containing a segment to which an alternative pronunciation must be assigned, yet he found no evidence of different pronunciation latencies for these words and words which are regular by any definition (e.g. pill). A group of "true" exception words which have unique or very unusual letter-sound correspondences did elicit longer pronunciation latencies. Glushko's model can only account for this finding if it is considerably modified so that segments have different potential for producing conflict according to the number of lexical items in which the minor correspondence occurs. Parkin points out that his results can also be explained in the context of a dual-process model if the grapheme-phoneme conversion system is assumed to contain "higher order" rules which operate on units larger than the grapheme, this being the assumption made by Patterson and Morton (1985) discussed earlier in this section. Parkin notes further difficulty for Glushko's model based on response accuracy rather than response latency. He argues that in the case of "true exception words" where there is a great weight of conflicting information, one would expect mispronunciations to be frequent when speeded responses are required. Yet the majority of exception words are rarely or never mispronounced. It would seem, therefore, that the information about pronunciation provided by a perfectly-matching lexical entry carries more weight or has greater salience than that provided by sub-lexical units. Glushko's model thus becomes "an implicit two-route model in which two potential sources of phonemic information are distinguished." In fact, Kay and Marcel (1981) explicitly state that whole-word phonology carries more weight than the phonology of sub-lexical units. "In the case of words, the pronunciation produced by the complete letter string will override any competing pronunciations produced by subsequent segments." The privileged status enjoyed by whole-word phonology does tend to undermine the notion of a truly unitary system.

In spite of these criticisms, there is no doubt that the results of Glushko's experiments pose problems for the standard model, especially as the slower pronunciation of inconsistent nonwords was observed even in a condition in which all stimuli were nonwords which might have been expected to encourage use of a nonlexical strategy. It is, however, difficult to explain the selective impairment of nonword reading in terms of Glushko's model as it is to explain it in terms of Shallice's model. To restate this problem in slightly different terms, we have found patients in whom the account must include the assumption that smaller orthographic units are most susceptible to the effects of cerebral insult and patients whose reading disorder can only be explained by making a converse assumption that larger orthographic units are most susceptible. The double dissociation suggests independent stores of large (morphemic) and small (graphemic) orthographic units. It is less plausible to suggest that individual entries in a unitary system may be selectively impaired.

Lexical analogy models have recourse to an alternative explanation of the deficit in nonword reading. Lexical entries are the basis of word and nonword reading and certain processes are necessary for the latter but not for the former. If no whole word representation is available, lexical entries containing appropriate segments must be activated, segmented, and the segments thus obtained blended before output. Patterson and Marcel (personal communication) suggest that these processes, specifically that of segmentation, rather than the segmental store may be implicated in cases of inability to read nonwords. This explanation cannot be advanced in support of Shallice's model since the visual-word form system contains units of all sizes. Nevertheless, the series of operations proposed by Marcel does seem to imply an extreme lack of economy in the system. The same tedious procedures of multiple activation and segmentation must be carried out repeatedly, yet these processes would be quite unnecessary if segments could be stored non-lexically. As Saffran (1985) explains, "It seems highly unlikely that a normal reader could regularly be exposed to sets of words like *gaze*, *maze*, *daze*, etc., and fail to deduce, and to encode in memory, the relationship between *aze* and /eɪz/". This point may be made even more strongly in the case of single letter correspondences. To reach the conclusion that *b* is normally realized as /b/ via the activation of every single lexical item in which *b* appears in the initial position and the subsequent segmentation of the phoneme in each case (and the literate adult may have a store of such items which runs into hundreds) seems an inordinately complex process which could easily be circumvented by storing the correspondence *b* → /b/ non-lexically.

Kay and Marcel (1981) present experimental evidence for Marcel's model using a primed nonword reading task with normal subjects. They found that pronunciation of inconsistent nonwords was influenced by the pronunciation of a preceding word. For example *nouch* tended to be pronounced /naʊtʃ/ when preceded by *couch* but /nʌtʃ/ when preceded by *touch*. Kay and Marcel were able to demonstrate that this effect did not arise at the pronunciation stage since orthographically dissimilar words did not influence the pronunciation of nonwords (e.g. prior presentation of shed did not elicit the pronunciation /jɛd/ in response to yead). These results can be partially assimilated to an extended 2/3 route model which postulates a non-lexical store containing alternative correspondences for graphemic units. In fact Meyer et al. (1975) do interpret similar priming effects obtained in a lexical decision task as resulting from priming of grapheme-phoneme correspondences. Kay and Marcel's results do, however, like the findings of Campbell and Besner discussed earlier, encourage reconsideration of the assumption that lexical and phonological routes are entirely autonomous. Related work by Rosson (1983) purports to demonstrate lexical involvement in nonword reading. Rosson used three versions of an indirect semantic priming task (this paradigm being preferable to a direct priming paradigm in obviating priming at the visual encoding or articulatory stages). In the first task, a nonword which was orthographically and phonologically similar to a word was used to prime another word which was either semantically related or semantically unrelated to it. Semantic relatedness of a nonword prime reduced pronunciation latency for words in Rosson's first experiment (e.g. famb speeded the pronunciation of sheep, presumably via the activation of lamb) but in the reverse situation, semantically-related word primes did not reduce pronunciation latency for nonwords (e.g. salt did not speed the pronunciation of depper). In a third experiment Rosson primed inconsistent pseudowords with words semantically-related to regular and irregular orthographic neighbours of the nonwords (e.g. louch was primed by sofa (couch) and feel (touch)). Some effect of regularity/irregularity of the prime on pronunciation choice was observed although the regular pronunciation was chosen for over 80% of the stimuli. Pronunciation latency was not affected by the regular/irregular status of the prime. Although Rosson's findings do justify the conclusion that "lexical knowledge can contribute to the phonological representations of novel strings" (my emphasis), they suggest that the involvement is minimal and is possibly brought to bear only under very specific experimental conditions. The priming effect of nonwords on words in Experiment 1 may not be germane to the issue since, as Rosson herself points out, it may occur subsequent to pronunciation of the pseudoword. The data from Experiment 2 do not provide any support for the hypothesis that there is lexical involvement in nonword reading. Data from Experiment 3 do suggest such involvement. One possible reason suggested by Rosson for the contradictory results obtained in Experiments 2 and 3 is that the pseudowords used in the latter experiment were all ambiguous. The presence of an inconsistent segment, it is suggested, may prevent the quick and efficient assignment of a phonemic unit. Lexical involvement may only occur in this situation. It is also noteworthy that instructions to subjects stressed accuracy as well as speed of response in this experiment. It is possible that this instruction led to the adoption of a conscious analogy strategy of the type described by Baron (1977a,b), (see Note 4). It is surprising that, even under the accuracy instruction which might have been expected to delay performances, mean naming latencies for the inconsistent pseudowords in Experiment 3 were shorter than those for the consistent pseudowords used in Experiment 2. Furthermore, the proportion of "irregularisation errors" on inconsistent pseudowords which were primed with an irregular word was fairly low. If an activation and synthesis procedure were normally involved in nonword pronunciation, one might expect that almost all irregularly primed inconsistent pseudowords would be asigned an "irregularised" pronunciation. In fact the regular pronunciation was generated only 14% less often when the prime was irregular. This figure suggests that subjects were aware of the regular correspondence and tended to choose it in preference to an irregular correspondence even when the latter was present in the prime. Thus though there was a significant effect of prime status, the results are not compatible with the notion that the use of analogy strategy is the normal procedure in nonword reading, especially when the lack of an effect of prime status on response latency is taken into consideration.

I have discussed Rosson's experiments in detail because these findings nicely illustrate the inconclusiveness of the evidence relating to single-route versus standard models.

The evidence presented in support of the single-route hypothesis cannot be ignored and certainly confirms Baron's (1977a) observation that the use of lexical analogy is a possible strategy for nonword reading. What the evidence does <u>not</u> suggest is that lexical analogy is the only or even the most usual strategy for reading nonwords. The demonstration of a significant effect of nonword inconsistency on response latency or of a significant effect of prime type on the pronunciation of inconsistent nonwords is not enough to call into question the existence of the autonomous phonological route which is an essential feature of the standard models. Consideration of the proportion of irregularisation errors reveals a strong bias towards the production of regular correspondences in nonword reading.

Overall, more than 80% of responses made by Rosson's subjects contained regular correspondences. Glushko (1979) records an error rate of only 12.3% on inconsistent nonwords, 71% of these errors were irregularization errors. If the only method for assigning phonology were a lexical one, there is in many cases, no reason why a regular phonological realisation should be preferred to an irregular one, even if frequency of occurrence is calculated during the decision process. Consider the nonword wead contained in Glushko's stimulus set. According to Glushko's account, this item is inconsistent because the segment ead occurring in the final position in words of similar structure (i.e. in which the segment is preceded by a single consonant) is realised in two alternative ways, as /id / or / ɛd /. The number of words in which the different alternatives occur is equal but the frequency of occurrence of these words favours the irregular realisation (dead and head, for example, are both high frequency words, in Thorndike-Lorge's AA category, whereas bead and mead are of much lower frequency). It has often been noted (e.g. Henderson, 1982) that exception words tend to be of high frequency. Knowledge of regular correspondence seem to form part of the competence of the normal reader; this knowledge may be explicit as shown by Barber and Millar (1982).

Indeed Patterson and Morton (1985) carried out a "mini-experiment" in which they presented a range of normal subjects with two nonwords for which there was a preponderance of irregular analogous pronunciations (pook and lind). Over 90% of subjects pronounced the first nonword according to regular correspondences and all subjects gave the second nonword its regular pronunciation. This is a clear indication of preference for regular correspondences in the absence of unusual experimental conditions (like the presence of a prime) which may elicit unusual strategies.

A further experimental finding relevant to this issue presents difficulties for all the single route models discussed, being entirely consistent with the notion of autonomous lexical and non-lexical routes. This is the finding of Frederiksen and Kroll (1976) that words are read aloud faster when in lists which contain only words than when they are presented in lists which contain words and nonwords. This result is explicable in terms of the need to distribute resources between lexical and non-lexical routes but is not predicted by models in which words and nonwords utilise the same procedures.

The process of deriving a phonological representation via a process of lexical analogy has not so far been specified in detail. It is therefore difficult to interpret experimental findings relevant to such processing. One question which requires investigation concerns the characterisics which a lexically-stored item must have in common with a letter-string in order for it to qualify as an orthographic neighbour. Henderson (1982) states that "the appropriate metric of resemblance is not yet fully determined but it relates to the size of shared letter-clusters and is greatest for shared final clusters". This claim has not been established empirically although it is consistent with Glushko's findings. Of possible relevance to this issue are the visual errors made by almost all acquired dyslexic patients (e.g. Morton and Patterson, 1980) and, in less than optimal conditions, by normal readers (e.g. Broerse and Zwaan, 1966; Bouma, 1973). Later work by Glushko (1981) goes some way towards providing empirical support for this claim. Glushko recorded naming latencies in a task in which target words were preceded by different types of prime. He found that monosyllabic words sharing all but the initial cluster yielded a larger priming effect than those that differed medially or finally.

The production of visually-similar words in response to visually presented words or nonwords must surely involve the activation of orthographically similar real words. Consideration of any acquired dyslexic error corpus indicates, however, that the majority of visual error responses do not share a final segment. Morton and Patterson (1980) consider the visual error responses of two deep dyslexic patients and note that the tendency is for responses to match at the beginning of the word rather than the end. In the corpus supplied by Patterson for the patient PW (Coltheart et al., 1980) only 30% of visual error responses share the final segment (as exemplified by Glushko's (1979) stimuli). A common initial letter or initial segment was present in 55% of the error responses. The salience of the initial letter in similarity judgements between words has been demonstrated by Dunn-Rankin (1978). He took approximately 100 words from a newspaper article and asked normal adult readers to group those that they thought looked most alike. The first letter was perceived as the dominant visual characteristic by Dunn-Rankin's subjects. Since Kay and Marcel (1981) have established that the use of a word as an analogy is based on orthographic and not phonological similarity, it is somewhat surprising that the initial letter is assumed to carry so much weight in the activation process.

A related question is that of the unit of matching. Glushko (1979) assumes (though does not explicitly state) that it is the final segment (VC, VVC or VCE) which retains its integrity, while the initial consonant or consonant cluster is substituted. His classification of words and nonwords as consistent or inconsistent depends heavily on this assumption and nonwords would be categorised differently if segmented differently. For instance, the nonword mear is inconsistent if segmented m/ear because of the alternative realisations / ɪə / (e.g. in fear) and / ɛə / (e.g. in wear) but is consistent if segmented mea/r (mea is always pronounced / mi / as in meat, meal, etc.).

Marcel (1980) describes the segmentation process in a manner which formalises Glushko's implicit assumptions. According to Marcel, the letter-string is scanned from left to right and after the initial letter has been marked as a possible segment, each consecutive letter is bracketed with the letter or segment preceding it to yield "a series of ever larger segments". The final segment would be identified early in the proceedings because once the initial letter is marked, what remains is a potential segment. If no segment which matches a lexically-stored segment is identified, phonology is assigned at the level of individual graphemes. The appropriate phoneme corresponding to each grapheme is segmented from a lexical item since there is no non-lexical store of grapheme-phoneme correspondences. Marcel's account clarifies the issue to some extent but experimental investigations with normal readers are needed to validate the account.

To summarise the present position with relation to the different types of model discussed, it seems that evidence of the use of lexical analogy in nonword reading forces the conclusion that an alternative strategy is available to the normal reader, although the precise nature of the operations involved are as yet unclear. The evidence presented so far in no way undermines the notion of an independent phonological route and evidence from acquired dyslexia shows that the lexical and phonological routes can operate entirely independently.

If it is allowed that there are two possible strategies for reading nonwords and that these strategies operate independently of one another, one being located within the lexical system, then we might expect to find neurologically-impaired readers who are able to utilise one strategy for nonword reading but quite unable to utilise the other. I have observed such a dissociation in one patient, the phonological dyslexic PM (Bradley and Thomson, 1984) in whom the ability to use the phonological route was totally lacking in ordinary nonword reading tasks, while success rate was raised from zero to 57% when test conditions demanded the use of lexical analogy. Even with the use of analogy strategy however, PM's ability to read nonwords was still impaired relative to his word reading ability and the original interpretation of the results in terms of a proposed link between the lexical and the phonological routes may have more explanatory power. This interpretation has been criticised by Barry and De Bastiani (in press) who maintain that PM's reading abilities support analogy theory and provide no basis for postulating additional links within a 2/3-

route model. However, analogy theory cannot explain the phonological manipulations which PM was able to make when the analogous word supplied was phonologically distant from the nonword target. The existence of some interaction between the lexical and the phonological routes, in addition to explaining certain anomalous findings with normal readers (e.g. Campbell and Besner, 1981) would also account for the frequency with which both strategies for nonword reading cease to function, notably in cases of acquired deep dyslexia, since the same mechanisms could subserve both types of processing.

A highly relevant point regarding possible interaction of routes is made by Morton and Patterson (1985). They note that there is a distinction between separability and independence which is an important one for the neuropsychological approach. Two routines which do not normally operate to tally independently may still be separable. Separability is indicated by selective impairment following neurological insult.

NOTES FOR CHAPTER 1

1 It is possible that these alternative options may not be available for speakers of languages in which spelling-to-sound correspondences are entirely regular. It has been shown that Serbo-Croation subjects were unable to suppress phonological coding even when its occurrence reduced efficiency of performance (e.g. Turvey et al., 1984; Lukatela et al., 1980). The authors do not, however, question the ability of English speakers to use alternative strategies.

2 This route is, in a sense, lexical, in that its subsystems operate only on letter strings which already have entries in the visual and oral word representation systems. The term 'lexical' has, in the main, been used to refer to a semantic lexicon which leads to the claim made by Henderson (1982) that the term 'nonlexical' "denotes only independence from the semantic lexicon". I am not in agreement with Henderson's statement that this direct link "would have to be classed as a nonlexical route" but avoid using either term as a descriptive

label for this route in view of their ambiguity. Marshall's (1984) term 'direct route' is neutral on this point and I shall adopt Marshall's terminology.

3 Patterson and Marcel administered 2 orthographic resegmentation tasks. The data referred to here relates to the second task. The following description of the tasks was kindly provided by Dr. Patterson (personal communication):

Orthography (1): Segment matching. The patient is given a list of pairs, each pair consisting of either two words or two nonwords. In each pair, one item is printed in upper case and one in lower case. 24 pairs have one letter in common (e.g. laughed and MOVING; 24 pairs have 2 letters in common (e.g. OCEAN and graced). The patient is instructed to underline the letter(s) in common. This task was blocked for segment size: thus the patient knew in the first set of items that he was only looking for one letter in common, and knew in the second set that it would always be two letters.

Orthography (2): Word completion. The patient is given a list of pairs; the item printed on the right is always a word but it is missing either one or two letters (this gap is underlined); the missing letter(s) can have any location in the word. N = 45 one-letter and 45 two-letter items. The letter-string on the left may be either a word or a nonword. Everything is printed in upper-case. The patient is instructed to find the letter(s) in the item on the left which, when inserted into the gap in the letter-string on the right, will make it into a word. This task was not blocked for segment size; thus the patient never knew, for any given item, whether he needed to find one letter or two, and the gap size gave no clue (it was a constant size). If two letters were required, by the way, they were always together and in the same order (e.g. GHOUL FIT).

In some pairs, like the example just given, the phonology of the target letter(s) was different in the source word and the completion word; in other pairs, it was the same. A further manipulation within the 2-letter items was that the letter pair could either be a 'natural' graphemic segment (in the sense of corresponding to a single phoneme, as in EA, TH, etc.) or an 'unnatural' graphemic segment (2 letters occurring together but corresponding to separate phonemes, as in OT or AL). This task is meant to assess whether the person can segment internal orthographic representations; one potential problem with the test is that it depends upon an ability to spell.

4 It should be noted that these models do not propose the conscious use of lexical analogies in the manner proposed earlier by Baron (1977a,b). Baron found that the instruction to subjects to use words they already knew to determine the pronunciation of pseudowords improved their performance. This suggests that analogy strategy was not brought into play spontaneously, although in an earlier experiment some spontaneous, though necessarily conscious use of the strategy was reported by subjects.

Chapter 2

PHONOLOGICAL DYSLEXIAS AS A CATEGORY OF ACQUIRED DYSLEXIA

2.1 The symptoms associated with phonological dyslexia

2.1.1 Introduction

A working definition of phonological dyslexia was offered at the beginning of Chapter 1. The discussion which followed concluded that the definition requires modification if phonological dyslexia is to be described as a syndrome in the strong sense of that term. The symptoms (positive and negative) which are associated with phonological dyslexia will now be discussed in relation to the theoretical models described in the preceding section.

The current taxonomy of the acquired dyslexias was developed against the background of the standard (two- or three-route) model, e.g. Marshall and Newcombe, 1983 and the greater part of the discussion which follows will be in terms of this type of model (which will later provide the theoretical background for experimental investigation. The evidence against such a model has been considered and shown not to necessitate its rejection. Furthermore, as noted earlier, the very existence of a selective impairment of nonword reading is less convincingly explained in terms of single-route models.

Reference to individual cases of phonological dyslexia will be made; these cases will be discussed more fully at a later stage.

2.1.2 The reading of nonwords is impaired...

The impairment of nonword reading is the critical symptom of phonological dyslexia and may be explained in the context of the standard model in terms of deficient functioning of the non-lexical phonological route. To this extent, the symptom has a firm theoretical base. It is not unproblematic, however, since the impairment of nonword reading is also a symptom of deep dyslexia. In the majority of cases of deep dyslexia, the ability to read nonwords is entirely abolished; Coltheart (1980b) states that all but one of the deep dyslexic patients discussed showed a "complete" inability to derive phonology from print by any non-lexical methods (my emphasis). Phonological dyslexics tend to be able to read some nonwords (e.g. AM; Patterson, 1982). The question is, can the two varieties of dyslexia be distinguished on the basis of the severity of the nonword reading impairment? A basis forthe distinction would be that in deep dyslexia, the phonological route is non-functional while in phonological dyslexia, it is merely impaired. Counter examples show that this would be an empirically unsatisfactory method, quite apart from the difficulty of establishing a theoretically valid cut-off point. The (problematically) deep dyslexic AR (Warrington and Shallice, 1979) was able to read more than 20% of nonwords while the phonological dyslexic WB (Funnell, 1983) was unable to read any non-homophonic pseudowords correctly.

2.1.3 .... relative to the reading of words.

The majority of cases of phonological dyslexia reported in the literature, perform extremely well on tests of word reading, and, as Patterson (1981) points out are likely therefore, to show a larger word/nonword dissociation than do deep dyslexics. An atypical case is the patient JS, reported by Martin (1982). JS read 15% of non-pseudohomophonic nonwords and only 38% of words (although words and nonwords were not matched for length and structure). This difference is less marked than that observed in many phonological dyslexics (Funnell's 1983, patient WB, for example read no nonwords and around 90% of words) yet Sartori et al. (1984) include JS in their review of reported cases of phonological dyslexia.

With respect to the theoretical justification discussed in relation to the impairment of nonword reading, it must be recognised that, if impairment of the non-lexical phonological route is the single causal factor in this pattern of dyslexia, impairment of this route gives no basis for predicting the level of word reading ability. Sparing of the lexical and/or the direct routes may or may not be found in a patient in whom the phonological route is non-functional. If phonological dyslexia is to be explained in terms of the standard model as the failure of one route and hence to be regarded as a neurological syndrome in the strong sense of this term then, unless modifications to the model suggest interactions between the lexical and non-lexical route, it must be regarded as a single-symptom syndrome, the only observed symptom being impairment of nonword reading. On this account, the "concrete word dyslexic" CAV (Warrington, 1981) must be regarded as a phonological dyslexic in spite of his severe impairment in reading words. On a matched set of 4- 5-letter words and nonwords, CAV read 3/20 words and 1/20 nonwords correctly. The difference between word and nonword reading is not significant in this case yet if we are describing phonological dyslexics as patients in whom the phonological route is inoperative, then there seems to be no theoretical justification for excluding patients in whom word reading is also impaired providing that it can be shown that the pattern of reading impairment does not result from failure at an early stage of processing common to both routes (i.e. at a sensory visual or at the early visual analysis stage). CAV was significantly affected by varying the concreteness of real word stimuli. This sensitivity to concreteness implicates the semantic system as the locus of impairment. If real word stimuli are reaching the semantic system, the sensory visual system and the early visual analysis system must be functional and there is no reason why the latter processing unit should respond differently to words and nonwords.

If, however, the only defining characteristic of phonological dyslexia is impairment of nonword reading, then the classification symptom not only fails to distinguish phonological from deep dyslexia, it also fails to distinguish phonological from surface dyslexia in some cases. Surface dyslexia (first reported by Marshall and Newcombe, 1973) is interpreted as reliance on a non-lexical phonological route, the lexical semantic route being severely impaired, although semantics can be obtained via the assembled phonological representation[1]. Whether reading performance in surface dyslexia ever reflects normal functioning of the phonological route in isolation is debatable. Most authors feel that the weight of the evidence suggests that it does not or that it does so only in a particular sub-type of surface dyslexia which has been termed "semantic dyslexia" (e.g. Shallice et al., 1983; Henderson, 1982, Ch. 5) although parallels can be drawn between the reading performance of the surface dyslexic and that of the cerebrally intact beginner reader (Marcel, 1980). Examination of the errors made by at least some surface dyslexics appear to reflect "faulty grapheme-phoneme translation" (Marshall and Newcombe, 1983) rather than being straightforard regularisation errors which could be produced by a normally-functioning phonological route when stimuli are exception words. For example, the error (made by Marshall and Newcombe's (1973) patient JC) resent → "rissend" must result from loss of or impairment to the rule "t → /t/" since, in this example, t is realised as /d/. Thus, according to the definition of phonological dyslexia as it has been explicated so far, some surface dyslexics would be subsumed under the title "phonological dyslexics". It seems, therefore, that the "relative to word reading" clause must be retained in the definition in spite of the impossibility of establishing the extent to which performance on the two types of stimuli must differ. This clinically descriptive statement correponds to the theoretically-motivated statement that in phonological dyslexia not only is the phonological route impaired but the lexical-semantic route is relatively unimpaired. A certain amount of imprecision must be tolerated here in respect of the word "relatively" because most phonological dyslexics are not 100% successful at word reading. (In fact, "pure" case of phonological dyslexia in which difficulty in reading nonwords was the only symptom would be of great theoretical interest since it would establish absolutely the independence of the phonological and of the lexical and direct routes). Symptoms which reflect reliance on the phonological route (i.e. regularisation errors and the tendency to confuse the meanings of homophones) should not occur and these negative symptoms could perhaps be included in the definition. This would help to exclude the case of surface dyslexia HAM (Kremin 1984) who, although unable to access output phonology via the lexical-semantic or direct routes did read nonwords less well than words.[2]

The assertion regarding differential performance on words and nonwords in no way helps to distinguish phonological from deep dyslexia. Deep dyslexics, though frequently more impaired than phonological dyslexics on word reading (Saffran, 1985, states that word reading performance in deep dyslexia is typically 50% correct) still retain more effective word reading than nonword reading skills.

2.1.4 **Visual errors may occur**

Almost all reported cases of acquired dyslexia of whatever variety make some visual errors; the actual proportion of this type of error varies. Thus Patterson (1979) records the proportion of visual errors made by the deep dyslexic PW as 13% while for the deep dyslexic KF (Shallice and Warrington, 1975) the proportion of visual errors was 61%. Marshall and Newcombe (1973) report that the surface dyslxic JC made occasional visual errors. The classification of these errors is less clear-cut in surface dyslexia since an error involving the substitution, deletion, addition or reordering of a letter or letters could be interpreted as failures of grapheme-phoneme conversion if it has been established that the patient is relying on the phonological route. Masterson (1985) reports that the proportion of such errors (which she terms "graphic errors") made by the surface dyslexic EE was 21%. Misidentification of letters is a feature of letter-by-letter reading in the majority of though not in all reported cases (e.g. Patterson and Kay, 1982; Prior and McCorriston, 1983). Roughly 45% of the errors made by the phonological dyslexic WB (Funnell, 1983) were visual (some visual errors could have been phonemic or semantic) and 86% of the errors recorded for the phonological dyslexic PM (Bradley and Thomson, 1984).

From the point of view of clinical diagnosis, therefore, the occurrence of visual errors is hardly a useful symptom. Theoretically, the mechanism by which such errors occur is not understood. It is probable that the mechanism differs according to the variety of dyslexia present. Most obviously the error must occur at the level of letter identification in letter-by-letter dyslexia and surface dyslexia (if the errors are truly visual and not errors of grapheme-phoneme conversion) while it is probable that the error is made at the whole-word level in phonological and deep dyslexia (particularly in those cases of deep dyslexia in which the patient has difficulty identifying the component letters of a word). Patterson and Kay (1982) found that in the majority of letter misidentifications in letter-by-letter dyslexia, the response was visually similar to the target showing visual features with it and that the errors overlapped with errors of normal subjects asked to identify letters under sub-optimal conditions recorded by Bouma (1971). Morton and Patterson (1980) discuss possible accounts of the occurrence of visual errors in deep dyslexia and site the lesion at the point at which the visual word representation (in fact Morton and Patterson's account is in terms of the logogen model; they use the term visual input logogen) must access a semantic representation. The visual error is, on this account, a second attempt following failure of a visual word representation to elicit a semantic representation. Consistent with this explanation is the tendency noted by Morton and Patterson (1980) for visual errors to be made on abstract words for which semantics may be harder to obtain. It has also been found that in a number of cases of deep dyslexia (e.g. Nolan and Caramazza, 1982) the visual error response tends to be more concrete than the stimulus. Thus these errors can be accounted for in terms of a semantic deficit although the reason for the dissociation is unclear. Shallice and Warrington (1975) and Marcel and Patterson (1978) note a possible basis for the distinction relating to language acquisition. The basic component of the meaning of certain words may be acquired relatively directly from visual experience. Richardson (1975) attributes superior performance on concrete words to the possibility of the use of visual imagery in the comprehension of these words. Richardson's account however, predicts that there should always be a concrete word advantage, yet, Warrington (1981) describes a patient who read concrete words far less well than abstract ones.

This account is, in any case, untenable in relation to phonological dyslexia since the patient WB (Funnell, 1983), in whom the direct route was functional, made visual errors (these accounted for 45% of his error reponses). Sartori et al., (1984) note that in phonological dyslexia, there appears to be a qualitative difference in visual error responses in that there is no tendency for them to occur primarily on abstract words or for error responses to be more concrete than targets. The alternative account proposed by Patterson (1978) and discussed by Morton and Patterson (1980)[3] which identifies the visual word recognition system (visual input logogen system) as the locus of the impairment leading to visual errors more easily explains visual errors in phonological dyslexia. This account states that (in logogen terms) there are abnormally high thresholds for certain words and that when output is blocked, a visually/graphemically similar logogen is allowed to exceed threshold. In terms of the standard model, this statement would be rephrased in terms of difficulty in accessing certain visual word representations. If the system senses that a representation is present but cannot be accessed, a visually similar alternative is output to the semantic or output phonology system. An alternative account can be offered in terms of failure to select the correct match from a range of visually similar representations which are activated following presentation of a single word.

A problem for the account based on the standard model's visual word representation system is the preserved ability to make lexical decisions in some patients who do produce visual errors. If visual errors are few and occasional errors are made on lexical decision, there is no incompatibility. Lexical decision scores and proportions of visual erros are unfortunately not available for all cases of phonological dyslexia. In cases in which they are recorded, the preserved abilities do not seem to pose serious problems for the account. For example, AM (Patterson, 1982) made only 1 lexical decision error in spite of being presented with 4 lexical decision lists each containing 34 items but his visual errors were rare - only 5 responses in 300 words if the category "derivational errors" is retained. AMM (De Bastiani, Barry and Carreras, 1982) was slightly less efficient at lexical decision. She made a correct decision on 97.4% of words and 89.5% of nonwords. She produced 9 visual error responses on a list of 100 words.

In summary, the mechanism(s) which produces visual errors in phonological dyslexia is not fully understood, although plausible hypotheses are available and hence the theoretical implications of the occurrence of visual errors cannot be thoroughly assessed. There appears to be no reason to claim that visual errors are necessarily associated with reliance on the lexical route and impaired phonological coding abilities, although concurrent phonological processing of visually-accessed words would presumably make confusion of visual word representations less likely to occur. The widespread occurrence of visual errors in different varieties of acquired dyslexia renders such errors insignificant for the purpose of diagnosis. Although visual errors in different types of acquired dyslexia should be distinguishable on the basis of their origin in whole-word or single letter confusions, the distinction would, in practice, be extremely difficult to make.

I have noted in earlier discussion that a possible account of visual errors is in terms of selection failure in the visual word representation system. In the case of a single-route lexical pooling model (as proposed by Marcel, 1980 and Henderson, 1982) the account would presumably be in terms of the failure to select an accurate match from the group of orthographic neighbours of the stimulus. The precise mechanisms involved in this process are not clear however.

The empirical evidence is not easy to reconcile with the "orthographic neighbours" account since proponents of the lexical analogy model assume that the final segment of a monosyllabic word corresponds to the unit of matching while an examination of the visual errors made by deep dyslexic patients shows that the initial letter or letter group influences the visual error response (Patterson, 1980).

2.1.5 Derivational and inflectional errors may occur

Difficulty in processing affixed words, typically involving substitution or deletion of the affix is frequently reported in both deep and phonological dyslexia. Coltheart (1980b) reviewing deep dyslexia, notes that there are no reports of deep dyslexia in which it is explicitly stated that such a patient does not have difficulty with affixes although there are a few cases where the dimension was not considered (e.g. Goldstein, 1948, Case 23). The occurrence of morphological errors is reported less consistently in cases of phonological dyslexia (Sartori et al., 1984). Whether such errors should be regarded as symptomatic of phonological dyslexia is as yet uncertain. Saffran (1982) draws attention to a difficulty peculiar to the interpretation of associated deficits in neuropsychology thus:

> "The problem is that co-variation may be due to overlap in the anatomical distribution of cognitive subsystems and not necessarily to functional dependency."

This caveat is explicitly applied to the issue of phonological dyslexic symptoms by Saffran (1985).

> "The lack of consistency suggests that the association between impaired phonological recoding and difficulty in reading grammatical morphemes in phonological dyslexia may reflect proximity of the anatomical subsystems that subserve these functions, and hence their common susceptibility to focal brain disease rather than functional interdependence."

Patterson (1982) tentatively proposes a theory in which there is a causal relationship between impaired phonological coding abilities and difficulty with reading affixes. Patterson's account is based on the model proposed by Shallice and Warrington (1980), in which there are 2 routes to reading, one via a visual link with the semantic system, the other via a phonological system which operates on morphemic and sub-morphemic units of varying sizes (see earlier discussion). The semantically-mediated route is not particularly efficient at dealing with morphemes which serve a largely syntactic role. Hence such morphemes would normally be handled by the phonological system. If the phonological system ceases to function efficiently the ability to obtain phonology for these morphemes would be lost. In Shallice and Warrington's model the phonological system contains morpheme-sized segments and hence the procedure by which phonology for affixes is obtained by the normal reader is not unduly complicated (i.e. it does not require that phonemes be allocated at the level of single graphemes, this process being followed by a process of blending) which lends plausibility to the account. It is possible however, to adopt such an account based on the standard model.

Seymour and MacGregor (1984) favour such an account of the morphological errors of a developmental dyslexic in the context of a two-route model noting that "the occurrence of derivational errors could indicate that the features used for logographic word recognition tend to be clustered on the word stem."

In this case the processing of affixes would be handled by the phonological route. Of crucial importance to this version of the account is the issue of the point at which morphological decomposition occurs within the reading system. If stem and affix are to be handled by the lexical-semantic and phonological systems respectively then they must be identified immediately after early visual analysis prior to the visual word recognition system (refer to Fig. 1.5). The ability to assemble phonology is, on this account, a prerequisite for affix reading and derivational errors should always occur when the phonological route is impaired. The pattern of reading behaviour reported for WB (Funnell, 1983) is thus imcompatible with this account since this patient made very few (5/38) derivational errors and made no more errors on affixed words than on any other word type in conjunction with an almost total inability to assemble phonology.

The details of the operation of such a recognition system for affixed words have not been well specified; the operations which would be required for such a system to operate efficiently seem to pose a number of problems for the model. In the context of an independent route model phonology for base morpheme and affix could not be linked until representations for each had reached the response buffer. Yet the operation of blending segments prior to output could not be carried out within a storage system and thus the process seems to require the inclusion of an additional blending system into which phonological representations for both stem and affix are fed. Additionally, since the derivational errors made by dyslexic patients very rarely result in the substitution of inappropriate affixes, there must be, as noted by Patterson (1980), "somewhere a list (or a set of rules by which such a list could be generated) of legitimate affixes or derivational forms for each root."

A further complication is that, although many affixes do perform a largely syntactic function, others clearly have semantic content. Consider the prefix un. There is an important semantic distinction between, for example, happy and unhappy which seems to indicate that such a prefix must enter the semantic system at some point. By contrast, the suffix ly does not make any important semantic addition to the morpheme happy. The argument for processing without access to the semantic system is more forceful in relation to the latter than to the former example. If some affixes must eventually access the semantic system, the requirement that they obtain access by such an indirect route reflects an implausible lack of economy in the system.

An alternative account of the processing of affixes is proposed by Job and Sartori (1984) who suggest that there exist separate visual recognition devices for stem and affix which may or may not be interlinked. Thus an affix is not routed separately from its base morpheme but accesses a visual match within the same system as the base morpheme. Whether this recognition occurs _after_ the whole word has been visually recognized (i.e. in Marshall's (1984) post-lexical morphological decomposition system), _before_ whole-word recognition, or is a substitute for whole-word recognition (which becomes morphemic recognition) is not specified. The authors note that they are primarily concerned with "the need for postulating visual recognition devices for affixes" and that their arguments "will not address the issue of the actual ordering of the processing stages". They argue that their account explains the errors on affixed words, observed in the error corpora of their patient, Leonardo, and of other deep and phonological dyslexia, in which the morpheme rather than the affix is substituted. It is also able to explain Leonardo's ability to read affixes presented in isolation better than nonwords. It should be noted that WB (Funnell, 1983) could not read affixes presented in isolation. Job and Sartori suggest that the contradiction be resolved by assuming that some components of the reading system are language-specific (Leonardo is a native speaker of Italian) or that it is possible for the affix "input recognizers" to be selectively impaired. The contradiction could also be resolved by specifying the locus of the decomposition system. If this processing stage follows whole-word recognition, the "affix recognisers" according to Marshall's (1984) model would be part of the lexical-semantic route. Leonardo may have been relying on this route. WB, however, was using the direct route from visual word recognition to whole-word output phonology and would thus be by-passing the morphological decomposition system.

In the absence of a well-specified account of the mechanism by which derivational errors are produced and reliable evidence that the ability to assemble phonology is required in affix-reading, the occurrence of morphological errors cannot be included as a symptom of phonological dyslexia. The frequency with which this error type is recorded in the context of deep and phonological dyslexia is interesting and requires investigation but functional interdependence has not, as yet, been demonstrated.

A final point to be made in connection with morphological errors concerns the issue of whether such errors do in fact represent a genuine class of errors. This issue concerns both the difficulty of distinguishing such errors from other categories of error and the need to distinguish different classes of error within the category.

Many authors (e.g. Saffran, 1984; Sartori et al., 1984) have noted that derivational error responses are both visually and semantically related to targets. Thus they might represent a sub-class of one or other of these error types. Patterson (1978) has argued that semantic and derivational/inflectional errors are distinguished by the confidence ratings which patients assign to them and by the responses in a forced-choice task. She also observed somewhat different patterns of response in visual as compared with derivational/inflectional errors. Additionally, in the majority of cases of phonological dyslexia, no semantic errors are recorded. Although there is some evidence that there are independent semantic systems which may be selectively impaired (Funnell, 1984) it seems implausible that semantic errors should be confined only to a set of stimuli defined on the basis of the presence of an affix rather than the presence of a particular set of semantic attributes. Thus in patients who make no semantic errors, the possibility of apparent morphological errors falling within this error category can probably be ruled out.

Unfortunately, the same argument can rarely be applied to visual errors since almost all deep and phonological dyslexics who produce morphological errors also make visual errors. The only patient who is explicitly reported as making no visual errors is JS (Martin, 1982) and unfortunately JS's case report makes no mention of derivational or inflectional errors. The reverse situation in which a patient made visual but very few morphological errors has been reported by Sartori and Job (1982). This patient (Beatrice) is a native speaker of Italian, a language which differs from English in being very regular in its spelling-to-sound correspondences. The demonstration of unimpaired word reading in conjunction with impaired nonword reading lends additional support to earlier unpublished work with Italian subjects cited by the authors which suggests that a dual-route model of reading is descriptive of reading in Italian. There seems, therefore, no reason to exclude evidence from Italian readers. If the morphological errors were simply a type of visual error then the occurrence of such a pattern would be highly unlikely especially as the stimuli with which the patient was presented included lists of inflected words.

Patterson (1980) reports a set of reading and lexical decision experiments using affixed stimuli in which acquired dyslexic patients showed evidence of separate processing of affix and base morpheme.

These patients both made derivational/inflectional errors and Patterson's demonstration of differential treatment of stem and affix offers some support for the notion that such errors do represent a genuine class of errors.

The most convincing evidence for visual and morphological errors being distinct error types is provided by errors in which the inflected form of the word does not resemble its base form visually. Unfortunately, such errors are rare in published error corpora (e.g. the deep dyslexic DE (Patterson, 1980) made only one such error: buy → bought, and even in this example target and response share the initial letter). Job and Sartori (1984) tested an Italian patient (Leonardo) on lists of regular and irregular Italian verbs. They argue that as regular verbs can be easily decomposed into root morpheme and affix, a patient making 'true' morphological errors should perform less well on regular verbs as indeed Leonardo did. However, the regular inflected verbs were presumably visually closer to their base morphemes than were the irregular ones since irregular forms do not share the orthographic form of root morpheme of the infinitive so that this result is inconclusive as evidence for or against morphological errors as a distinct error type. On Job and Sartori's account of the decomposition process, this dissociation in Leonardo's reading of inflected forms taken in conjunction with Beatrice's lack of sensitivity to the regular/irregular dimension of verbs, it does tend to support the hypothesis that they represent a distinctive class. However, there are inconsistencies in Job and Sartori's account (see earlier discussion of morphemic decomposition) which increase the difficulty of interpreting this pattern of reading behaviour.

A number of subdivisions of morphological errors can usefully be made. Firstly, inflectional errors should be distinguished from derivational errors. Inflectional endings differ from derivational endings in that they do not change the part of speech of the base morpheme. A part of speech effect in which nouns in English are read more efficiently than adjectives which are in turn read more efficiently than verbs, is observed in deep dyslexia (Coltheart, 1980b) and superiority of noun-over-verb reading is sometimes found in phonological dyslexia (Sartori et al., 1984). Patterson (1980) notes that nouns are less frequently suffixed than other parts of speech. Thus two impairments of reading may be confounded in the case of derivational but not in the case of inflectional errors. When errors are derivational, it is useful to record the parts of speech of target and response. Inflectional endings always perform a syntactic function, indicating for instance, tense or number. Derivational endings may have a primarily syntactic function, as for instance where the suffix "ly" is added to an adjective to form an adverb. In other cases the suffix carries semantic information (e.g. piano/pianist). The two types of inflectional ending mentioned above may also differ in their semantic importance according to part of speech. It has been assumed for instance, that the marking of number on nouns carries semantic information while number agreement of verbs is a purely syntactic function (e.g. Davis et al., 1978; Shanon, 1973). Finally, there may be theoretical motivation for a distinction between errors on prefixes and errors on suffixes since it has been suggested (see earlier discussion) that prefixes and suffixes may be separated from the base morpheme at different stages in the reading process (Smith et al., 1984).

2.1.6 Function words may be read less efficiently than content words

A deficit on function words[4] as compared with content words is usually reported in cases of deep dyslexia (Coltheart, 1980b) and frequently though by no means invariably reported in cases of phonological dyslexia (Sartori et al., 1984).

Many of the theoretical arguments relating to the interpretation of this deficit are similar to those relating to the difficulty in reading affixes. However, I have treated the two deficits separately because interpretation of the latter is complicated by the issue of the stage at which morphological decomposition occurs. Furthermore, a dissociation between the deficits has been observed in phonological dyslexia. Patterson (1982) has established that the patients GRN and BTT (reported by Shallice and Warrington, 1980) were not impaired in their ability to read functors but were adversely affected by the presence of an affix. Leonardo (Job and Sartori, 1984) presented a similar pattern of impairment. Patterson's (1982) account of the role of phonological coding in reading certain classes of word was developed to explain the function word deficit as well as the difficulty with affixed words. The semantic system, it is suggested, is not well suited to processing functors and bound morphemes and these are therefore handled by the phonological system. The reported dissociation of deficits on the two classes of stimuli is explained (on the basis of Shallice and Warrington's (1980) model) in terms of the involvement of an additional process by which base morpheme and affix are separated in reading derived or inflected words. Functors may be stored as single phonological units in terms of this model. This account predicts that any phonologically impaired patient who has difficulty in reading functors should also be impaired on affix reading. The report of WB (Funnell, 1983) who was unable to assemble phonology yet was unimpaired on reading of functors and affixes poses a problem for this account in terms of Shallice and Warrington's model. However, in the context of the standard model, WB's pattern of impairment can be explained by the sparing of the direct route which should be as well suited to handling functors as it is to handling content words. Independent evidence of WB's reliance on this route (an impairment of the semantic system did not produce a significant number of semantic errors in WB's case) lends plausibility to this account. If the direct route is non-functional and the patient must therefore rely on the phonological route for reading functors, then it might be expected that some sparing of the latter route would aid performance on the reading of these words. This appears to be the case as a very general rule since phonological dyslexics who are frequently able to read some nonwords tend to be less consistently and less severely impaired in their ability to read functors than many deep dyslexics.

The assumption that the semantic system is not well suited to the processing of grammatical morphemes is an important one if it is to be argued that the deficient processing of grammatical morphemes is a consequence of impaired phonological processing. The finding that the deep dyslexic PW (Morton and Patterson, 1980b) retained a good deal of semantic information about some function words which he could not read aloud is difficult to assimilate to this hypothesis. Morton and Patterson (1980b) explain PW's difficulty with functors in terms of a loss of syntactic knowledge. Function words carry semantic and syntactic information in varying proportions and the loss of the latter leads to difficulty in processing these words which, Morton and Patterson argue, may be processed via the lexical-semantic route just as content words are. PW did indeed perform better on comprehension tasks when presented with function words which might be assumed to have a high semantic content (e.g. prepositions and adverbs of space). The precise location of syntactic knowledge within the logogen model (which is the background against which this explanation is set) is not known but it is assumed to be contained within the cognitive system wherein semantic knowledge is also stored (Morton and Patterson, 1980a).

Involvement of the cognitive system in reading functors is also suggested by the frequency with which errors on function words involve the substitution of another function word. Admittedly, such responses can frequently be explained by the visual similarity of target and response (e.g. not → no; off → of) but the majority of PW's error responses (recorded by Patterson in the Appendix of Coltheart et al. (1980)) do not bear visual resemblance to the target (e.g. both → perhaps; where → because). The frequency of function word substitutions suggests that the word is recognised as a function word and the response is picked from the appropriate class of word although it may be semantically distant from the target as it is in the latter examples. These substitutions are explained by Marshall and Newcombe (1966) in terms of Katz and Fodor's (1963) semantic theory in which the form class is the first item contained in a dictionary entry. Thus recognition of the form class of a word indicates that the minimum information is retrieved from the dictionary entry to provide a basis for the selection of the appropriate phonology. Although, as noted by Howard and Orchard-Lisle (1984), Katz and Fodor's description of dictionary entries has been criticised. Marshall and Newcombe's account of function word substitutions can be assimilated to alternative accounts.

Evidence that functors have entries in the whole word recognition system is provided by the ability to make accurate lexical decisions on function words (Morton and Patterson , 1980b; Patterson, 1982).

If it is allowed that the lexical-semantic route is to some extent implicated in the reading of function words then the imageability[5] effect observed in deep dyslexia is relevant to the question of selective impairment. In cases of deep dyslexia the function word deficit occurs in conjunction with a broader part of speech effect in which nouns are read better than adjectives which are read better than verbs. Performance on functors tends to be worst of all. It has been suggested that the part of speech effect is in fact a manifestation of the imageability effect (Funnell, 1983). Allport and Funnell (1981) found that the superiority of performance on nouns over verbs disappeared when imageability was controlled across the word classes. In this case, poor performance on functors simply reflects the tendency for such words to have low imageability ratings. Barry and Richardson (1982) also found that an apparent effect of syntactic class on word reading disappeared when other variables were statistically controlled and that associative difficulty, concreteness and frequency were the "effective determiners of reading performance" in a case of deep dyslexia.

Evidence from a deep dyslexic patient presented by Shallice and Warrington (1975) suggests, on the other hand, that not all of the part of speech effect can be explained by differences in imageability between word classes.

If imageability does account for a large proportion of the part of speech effect such an effect should always be observed in conjunction with an imageability effect on stimuli of the same word-class. The deep dyslexic AR (Warrington and Shallice, 1979) is the case that disproves this hypothesis. AR showed an imageability effect but no part of speech effect. Four phonological dyslexics AMM (De Bastiani et al., 1983), Raffaella and Leonardo (Sartori et al., 1984) have presented with the reverse pattern, showing a part of speech effect at least to the extent that verbs were read less well than nouns but no imageability effect. However these patients did not show a function word deficit and it is possible that the deficit on verbs was due to difficulty in processing inflected words.

The majority of stimuli presented to dyslexic patients have taken the form of words presented singly in isolation or word lists. The patient PM (Bradley and Thomson, 1984) showed no reduction of efficiency in reading functors presented singly but was observed to hesitate longer and more frequently before function than before content words in a passage of text. A more pronounced dissociation has been observed in the reading of RIC (Kremin, 1984) who was no more impaired on reading function words than content words presented in isolation while attempts at reading sentences "resulted in agrammatic productions where grammatical particles were mostly or totally omitted". Such a pattern is somewhat difficult to interpret in view of the fact that normal readers have been shown to make more errors on function than on content words in speeded oral reading (Morton, 1964a). Patterson (1982) has suggested that this results from the high semantic involvement in reading text. If the lexical-semantic route is normally used for this type of reading and grammatical morphemes are indeed inadequately specified within the semantic system, then the tendency for function words to elicit errors is not surprising. The occurrence of errors on functors in the reading of text by phonological dyslexic patients may result from a generalised impairment which exacerbates a proneness to error present in normal readers.

Relevant to the issue of reliance on different strategies in text- and single word- reading is the suggestion (discussed by Allport, 1979) that phonological or articulatory coding (and according to current reading models the latter is accessed after the former) is implicated in the comprehension of text, such coding providing "additional temporary storage after lexical access, until the meaning of larger syntactic units, phrases and sentences, has been satisfactorily analysed". The involvement of a phonological short-term store in processing auditorily- and visually- presented sentences is also investigated by Vallar and Baddeley (1984). This suggestion is important in any consideration of text-reading difficulty in acquired dyslexia but does not explain why there should be differential performance on content and function words.

On the evidence presently available it is impossible to reject Saffran's suggestion that the difficulty with reading grammatical morphemes (inflectional and derivational affixes and functors), though frequently associated with impaired ability to assemble phonology, simply reflects proximity of the anatomical subsystems subserving the two functions. Neither, however, can the possibility of functional interdependence be rejected. Because dissociations provide more reliable evidence than do associations of impairment in neuropsychology, it may prove easier to reject the functional interdepedence hypothesis than to confirm it. If a patient who shows no function word deficit and/or makes no derivational errors and in whom the direct route is non-functional is found, then such a patient would provide grounds for rejection of the hypothesis. Because Funnell's (1983) patient WB was apparently relying on the direct link between visual input and output phonology in reading aloud, his efficient reading of grammatical morphemes does not present a serious problem for the functional interdependent hypothesis.

Confirmation of functional interdependence is more difficult to find within the neuropsychological framework and studies using normal readers as subjects seem likely to prove more fruitful in relation to this issue. Experiments with normal readers which relate to morphological decomposition are fairly frequent in the literature and have been discussed in the preceding section. Experiments with normal subjects which address the issue of the function/content word distinction are less frequent. Bradley (1978) found an effect of frequency on lexical decision latencies when stimuli were content words but not when stimuli were function words. This result does suggest the involvement of different processes in the reading of the two word classes. However, Gordon and Caramazza (1982) found that closed-class items showed significant frequency sensitivity not distinguishable from that of open class items both on tasks similar to that used by Bradley and on an exact replication.

Within neuropsychology, the correlation between the degree of severity of the nonword reading impairment in phonological dyslexia and the extent to which the reading of functors is impaired warrants consideration. A severe phonological impairment accompanying a severe function word deficit (or a mild phonological impairment, a mild function word deficit) would be suggestive though by no means conclusive evidence in favour of functional interdependence.

2.1.7 Semantic errors are not observed

The semantic error has been generally accepted as being the critical symptom in deep dyslexia, following Coltheart (1980b) who claims that the occurrence of semantic errors in a patients' reading responses guarantees that eleven other symptoms which "constitute the symptom complex of deep dyslexia" will occur. Since the semantic error is accepted as the defining characteristic of deep dyslexia there can be no cases of deep dyslexia where semantic errors do not occur. There are however, cases in which few semantic errors are made and in which not all the eleven additional symptoms listed by Coltheart 1980(b)[6] are present. One such "borderline" patient is AR (Warrington and Shallice, 1979). Coltheart notes that the notion of deep dyslexia as a "uniform and homogeneous" syndrome can only be defended if AR is overlooked. Only 5% of AR's errors were semantic and his reading aloud of nonwords was not entirely abolished (he read 28% of nonwords on one occasion). He showed no function word deficit and read adjectives no worse than nouns. Coltheart also mentions that AR's performance on lexical decision tasks was poor. This latter impairment distinguishes AR from the other deep dyslexics discussed by Coltheart but does not relate specifically to any of the symptoms listed. Coltheart considers excluding AR from the category of deep dyslexics on the basis of the low proportion of semantic errors but notes that the patient KF (Shallice and Warrington, 1975) made a similar proportion (4%) of semantic errors and yet displayed all other symptoms of deep dyslexia. The patient WB (Funnell, 1983) made a few semantic errors (these account for 6% of errors made) and was unable to assemble phonology. Yet he showed no function word deficit (in fact no part of speech effect at all) and no effect of imageability. Funnell describes WB as a phonological dyslexic and this classification has not been disputed. In making a clinical diagnosis therefore, the semantic error is clearly an important symptom but does not, perhaps, have the privileged status attributed to it by Coltheart (1980b). Deep dyslexia is not diagnosed in the absence of the semantic error, its presence, however, does not guarantee that a patient is most appropriately assigned to this category of dyslexia.

Theoretically, a relationship between the semantic error and impairment of phonological coding abilities has not been established. Marshall and Newcombe (1973) argue that the semantic system is normally somewhat unstable as evidenced by the fact that cerebrally intact subjects can be induced to produce semantic errors under time pressure (e.g. Morton, 1964b) or when there is a memory component (e.g. Henley et al., 1968). Under optimal conditions, such errors are "blocked" in normal readers by the operation of the phonological route which would produce a phonological representation incompatible with the semantic error responses. This account is now untenable following reports of phonological dyslexia in which no semantic errors were made in spite of a severe phonological encoding deficit.

If there is no causal relationship between the phonological impairment and the occurrence of the semantic error, deep dyslexia must be regarded as resulting from two independent deficits, one within the non-lexical, the other within the lexical routes. Why a semantic deficit should so frequently take the form associated with deep dyslexic reading (with relative preservation of high-imageable words and nouns as opposed to other parts of speech and the production of semantic error responses) is unclear. Certainly a different pattern of impairment is possible as evidenced by CAV (Warrington, 1981) whose performance was better on abstract (low-imageable) than on concrete words and who made only 2 (1.8%) semantic errors. As stated in Marshall and Newcombe's (1973) account, semantic errors would presumably be blocked if the phonological route (or the direct route) were intact, so that, although the phonological impairment does not cause such errors, it is a prerequisite for their occurrence.

An alternative hypothesis is that deep dyslexia reflects the reading abilities of the right hemisphere (Saffran et al., 1980; Coltheart, 1980c). Data obtained by the former authors from split visual field studies with deep dyslexics is somewhat inconclusive and does not provide grounds for a firm acceptance or rejection of the hypothesis. The similarities between deep and phonological dyslexic reading and in particular the existence of "borderline" cases make this account somewhat implausible. On this view, the semantic error reflects the organisation of the reading abilities of the right hemisphere and should only occur in cases where all other features of right-hemisphere reading performance can be observed. The precise mechanisms which lead to the production of the semantic error response on this account or on the account of semantic errors as resulting from a lexical deficit within the normal reading process have not been established, although possible mechanisms have been discussed by Coltheart (1980d).

Since we do not understand why such errors occur in the reading of some dyslexics, it is unjustifiable to use the presence or absence of such errors as the criterion for assigning a patient to one or other category of dyslexia. In as much as the errors reflect some sort of impairment within the lexical-semantic route, it might be possible to maintain the distinction between deep and phonological dyslexia by saying that the lexical-semantic route is unimpaired in phonological dyslexia and impaired in deep dyslexia. However, few phonological dyslexics are 100% perfect on word-reading tests and if their errors cannot be explained by deficits outside the lexical-semantic system (for example, by establishing that grammatical morphemes are handled by the phonological system) then this distinction cannot be made. Furthermore, Funnell (1983) has demonstrated unequivocally that a semantic deficit can occur in the context of phonological dyslexia. The operation of the direct route in the case of WB forms another possible basis for a distinction between deep and phonological dyslexia, if it is assumed that this route is always unimpaired in phonological dyslexia and blocks errors which would otherwise result from an impaired or essentially unstable semantic system. The unmistakable effect of varying stimuli on the semantic dimension imageability in some cases of phonological dyslexia (Bradley and Thomson, 1984; Sartori and Job, 1982), indicates that some phonological dyslexics are also depending on the lexical-semantic rather than the direct route. The lack of a theoretically adequate account of the semantic error has implications not only for its status as a symptom but also for the question of the validity of regarding deep and phonological dyslexia as separate varieties of reading disorder.

2.1.8 The imageability effect

The lack of influence of this variable in phonological dyslexia is not mentioned in the working definition at the beginning of this chapter but the related lack of a concreteness effect is included as a critical symptom in the definition offered by Sartori et al., (1984). Some discussion of the imageability effect and its relationship to the part of speech effect has already been offered in connection with aspects of the function word deficit. In fact, an effect of this variable has been recorded in at least three cases of phonological dyslexia (Sartori and Job, 1982; Bradley and Thomson, 1984; Dérouesné and Beauvois, 1985).

Patients in whom such an effect is observed must be assumed to be reading via the lexical-semantic route. All three phonological dyslexic patients and the deep dyslexic patients discussed by Coltheart (1980b) performed better on high-imageable than on low-imageable stimuli. Since the reverse pattern has been observed (Warrington, 1981) this selective impairment of low-imageable lexical entries must be regarded as a specific type of deficit within the semantic system and not as a normal characteristic of reliance on the lexical-semantic route. This statement is reinforced by the fact that the majority of reported cases of phonological dyslexia do not show an imageability effect. The possibility of reliance on the direct route in such cases must be taken into account, however. The superior performance on nouns by comparison with verbs shown by some phonological dyslexics, may argue against this possibility since the direct route should not be susceptible to an effect of part of speech. However, this effect may be related to difficulty in reading inflected words (see section on derivational errors). Harder to explain are cases in which an imageability effect is observed (indicating reliance on the lexical-semantic route) in the absence of a function word deficit. Such a pattern suggests an alternative interpretation of the latter deficit as resulting from a further selective impairment within the lexical-semantic system.

2.1.9 Characteristics of nonword reading

Sartori et al. (1984) note that a certain pattern of error responses to nonwords is often observed in phonological dyslexia and that this pattern differs from that which is often found in cases of deep dyslexia. This pattern of responses is included by Sartori et al. within their description of phonological dyslexia as an associated, rather than a critical symptom. The observed pattern of error responses involves the production of numerous visually similar real words and some incorrectly produced nonwords. Omissions are few. This pattern contrasts with that associated with deep dyslexia which is characterised by a very high proportion of omissions, a small proportion of visually similar words and very few incorrectly produced nonwords. Sartori et al. suggest that these differing patterns may reflect quite different functional impairments in deep and phonological dyslexia. However, they do not specify the nature of these impairments and accept that "it is perfectly posssible that a damaged but not destroyed procedure for assembling phonological codes could produce the qualitatively different patterns of responses to nonwords "and that it is possible that deep and phonological dyslexia represent points along some continuum of functional impairment."

The high proportion of visually similar responses in phonological dyslexia may reflect reliance on the lexical route(s) even for nonword reading. Saffran (1984) notes the "relative preservation of lexical capacities in phonological as compared with deep dyslexics". Phonological dyslexics may find it easier to obtain a lexical representation by a process of "approximate visual access" while deep dyslexics who are able to respond less frequently to real word stimuli cannot access the lexicon by means of a letter string which only resembles a real word.

Unless different functional impairments underlying different patterns of error response to nonwords can be identified, the different patterns cannot be regarded as a theoretically valid means of distinguishing the two types of dyslexia.

2.1.10 Accompanying dysphasia and dysgraphia

The presence of a dysgraphia is listed as a critical symptom and the presence of an aphasia as an associated symptom of phonological dyslexia by Sartori et al. (1984). It seems unlikely that a return to classification by associated disorders (see, for example, Marshall (1984b) for discussion of this type of approach) will prove fruitful particularly at a level which does not even specify the nature of the aphasic or dysgraphic disturbance. Neuropsychological studies have shown that impairments in the different modalities can dissociate. Marshall and Newcombe (1983) discuss the occurrence of dysgraphia and dyslexia in isolation from one another and the co-occurrence of different types of dysgraphia and dyslexia. Sartori et al. (1984) note that phonological dyslexia has been observed in the context of fluent and non-fluent aphasia and in cases where aphasia is absent. Deep dyslexia, although frequently co-occurring with Broca's aphasia is, sometimes observed in the context of an aphasia which in no way parallels the reading impairment (Coltheart, 1980b). Models which take account of more than one modality show distinct modality-specific systems (Newcombe and Marshall, 1980; Morton, 1980; Ellis, 1982). The cognitive system is, in fact, the only system common to the processing of stimuli in all modalities. It would, therefore, be impossible, on the basis of such models, to propose necessary relationships between aphasic, dysgraphic and dyslexic impairments unless the common cognitive system is implicated as the locus of the deficit. This is not to say that the disorders accompanying dyslexia are of no interest, although it is clear that they must be specified in detail if they are to be of any theoretical import. There is, however, no justification in the inclusion of accompanying disorders in a list of critical symptoms of a variety of acquired dyslexia when current models provide the background for classification. The possibility of necessary links being established between aphasic and dyslexic symptoms has been discussed by Kremin (1984) who recommends "extending the information processing approach to reading units larger than the individual word"; such action should render "the functional relation between reading deficits and aphasic disturbances .... apparent and understandable." This conclusion may be over-optimistic. The problem of interpreting associations of symptoms remains and, judging from past experience, it seems probable that dissociations will continue to be observed.

2.1.11 Conclusions

The symptoms associated with phonological dyslexia have been discussed individually and those that may be regarded as critical, in the sense that they define the disorder theoretically, separated from associated symptoms for which no necessary theoretical link with the critical symptoms has been established. The discussion has thus considered the validity of the working definition of phonological dyslexia at the level of theoretical adequacy and at the level of clinical description. At neither level can it be regarded as entirely adequate.

The statement that nonword reading is impaired relative to word reading is crucial and theoretically justifiable. That nonword reading is impaired reflects damage to the phonological route as identified in the standard model of the reading process; the phrase "relative to word reading" reflects reliance on the lexical route and the fact that access to the semantic system is not dependent on a process of phonological assembly as it is in surface dyslexia. The latter point could be emphasised by the inclusion of a negative symptom such as the absence of regularisation errors which would clearly exclude cases of surface dyslexia in which there is damage to the phonological route. Regularisation errors on words should not occur in phonological or deep dyslexia since there is no mechanism within the lexical route which could generate such errors.

As yet no other symptom can be shown to be a necessary feature of phonological dyslexia resulting, either directly or indirectly from the impairment to the phonological route. Clinical reports have shown that no other symptom (including the negative symptom "absence of semantic errors") is invariably present in phonlogical dyslexia; this dissociation of critical and associated symptoms suggests that a direct causal relationship between an associated symptom and impaired ability to assemble phonology will not be found.

One conclusion which must be drawn from the discussion of individual symptoms is that there is currently no theoretical justification for a distinction between deep and phonological dyslexia. In both varieties of dyslexia, the phonological route is impaired; in both there may be some form of semantic impairment with consequent lowering of efficiency of the lexical-semantic route. In some cases of phonological dyslexia, the direct route may be functional; this route should not be functional in deep dyslexia. However this observation does not provide justification for a distinction between deep and phonological dyslexia, rather it indicates that there are at least two varieties of phonological dyslexia. Deep dyslexia, it would seem, is less appropriately conceptualised as phonological dyslexia plus some vaguely-specified lexical impairment and more helpfully viewed as representing a different point along "some continuum of functional impairment" (Sartori et al., 1984). In spite of this lack of theoretical justification for a distinction, the term "deep dyslexia" does carry some descriptive content and it may usefully be applied to cases which fall firmly within the confines of the clinical description proposed by Coltheart (1980b) serving its purpose as a form of "clinical shorthand". The terms deep and phonological dyslexia will therefore continue to be used in this work now that limitations on their use and meaningfulness have been explicated.

With regard to the associated symptoms of phonological dyslexia, it must be emphasised that, although causal relationships with critical symptoms have not been established, the arguments which have been advanced in support of such relationships have not been firmly rejected. All associated symptoms will therefore be investigatd and related to accounts which suggest causal relationships.

The inadequacies revealed by close examination of the working definition of phonological dyslexia may result from failure to isolate relevant symptoms at an appropriate level of detail. Discussion has revealed that what have been regarded as single symptoms may in fact cover an assortment of symptoms. For example, the term "derivational" errors has been shown to cover a variety of error types, each of which may conceivably have a different etiology. Mehler et al., (1984) have made a similar point with regard to the mapping between psychological processing and neurophysiological structures, arguing that if one-to-one mappings are to be found then there must be "some advance knowledge of what the units of analysis are at each level that enter into the mapping relationship". In the same way, if neuropsychological symptoms are to be theoretically interesting, they must map onto the subsystems of the cognitive models which underlie the current approach to neuropsychology and thus both symptoms and cognitive processes must be specified at the level most suited to the exercise.

The failure of the classification by accompanying disorders or "correlational approach" (Marshall, 1984) to provide an adequate framework for psychological investigation of neurological disorders, clearly results from the specification of symptoms at too general a level. To say that a patient is dyslexic or aphasic is only marginally more revealing than saying that a patient has a high temperature or is experiencing feelings of nausea. The latter symptoms which may be observed in association with numerous forms of anatomical damage or physiological malfunctioning may be assumed to be of little diagnostic value to the physician. The presence of a dyslexia or an aphasia may help the neurologist to identify possible loci of damage within the brain but are highly ambiguous from the psychologist's point of view since there are a multitude of different patterns of language disorder which result from different patterns of functional impairment.

Ideally symptoms should be identified which reflect impairment of a single-subsystem or the interaction of subsystems rather than a generalised lowering of performance on tasks which involve a number of sub-systems. Consider the impairment of the ability to assemble phonology which has been accepted as a critical symptom of phonological dyslexia. Although certain cognitive models of reading have presented the phonological route as involving the operation of a single system - "grapheme-phoneme conversion" (e.g. Morton and Patterson, 1980), more recent models have identified at least three subsystems within this route (e.g. Marshall, 1985; Temple and Marshall, 1983). If these subsystems are indeed functionally distinct then patients should present with different types of difficulty in assembling phonology resulting from the selective impairment of a single subsystem or of different combinations of subsystems. Some evidence of dissociations within nonword reading performance has indeed been offered (Dérouesné and Beauvois, 1979), and the sparing of certain skills involved in the process of assembling phonology investigated (Funnell, 1983), although other studies have not addressed the issue of fractionation of the critical symptom (e.g.

Shallice and Warrington, 1980). Thus one way forward in neuropsychological research is the precise specification of a number of subtypes of what appears to be a rather loosely-defined disorder. Saffran (1982) makes the point, in relation to the standard aphasia taxonomy, thus:

> "Rather than refining the description of functional loss <u>within</u> the standard aphasia categories as at present, the goal should be to progressively refine the categories themselves, drawing the lines of functional decomposition as narrowly as possible."

It should not however be inferred from the fairly lengthy discussion of the inadequacies and possible refinements of the definition of phonological dyslexia that the establishment of phonological dyslexia, indeed of any other pattern of reading impairment, as a syndrome in the "strong" sense is a prerequisite of future progress in the neuropsychology of reading. The role of the single case study in neuropsychological research has been evaluated (e.g. by Shallice, 1979; Marshall and Newcombe, 1984; Caramazza, 1984) and its value firmly established. Detailed study of a single case can provide evidence of dissociation of function and insight into the operation of residual symptoms regardless of whether the patient can be unambiguously assigned to a neuropsychological syndrome.

2.2 <u>Review of reported cases of phonological dyslexia</u>

The term phonological dyslexia was first used in 1979 by Beauvois and

Dérouesné. Patterson (1981) noted the paucity of published information relevant to this type of dyslexia in comparison with that relevant to deep dyslexia which had already been extensively studied. This need not, however, be taken as an indication that the pattern of reading impairment observed in phonological dyslexia is a rare one. Rather it reflects the infrequency with which tests of nonword reading were administered prior to the comparatively recent surge of interest in interpreting aspects of acquired reading disorders in terms of cognitive models. Low, who investigated an acquired reading disorder in 1931 is a rare exeption to this general rule. He presented a neurologically-impaired patient, who is now regarded as a case of deep dyslexia, with an exceptionally wide range of stimuli including visually-presented nonsense syllables. Early cases of deep dyslexia (not, of course, so-named by the investigating neurologist) were more likely to attract attention because of the occurrence of the semantic error (e.g. Goldstein, 1948; Weigl and Bierwisch,1970); the relatively efficient reading of real words in phonological dyslexia would have reduced the likelihood of the reading behaviour of such cases being thoroughly investigated. One early case which is almost certainly a case of phonological dyslexia is reported by Weisenberg and McBride (1935: case 4). This once highly-literate right-handed man, a Ph.D. and professor of Romance Languages presented with aphasia, dyslexia and dysgraphia following cerebral insult and was presented with nonsense syllables of two to four letters in length and with single letters which he was asked to sound. He was "uncertain, hesitant, and inaccurate" when presented with such stimuli although his reading of single words of graded difficulty was 93% correct. A more recent case which nevertheless preceded Beauvois and

Dérouesné's (1979) report by several years is reported by Bottcher (1974). Bottcher's patient "M" is clearly impaired at reading nonwords relative to words. Unfortunately, details of many aspects of reading behaviour pertinent to phonological dyslexia are not provided in this case report. Data from this patient is not therefore included in the summary tables.

Beauvois and Dérouesné (1979) argue that RG who was able to read only 10% of four-letter nonwords but made no semantic errors, is a "pure case" of phonological dyslexia of the type which combines with an additional impairment of word reading in deep (phonemic) dyslexia. The nature of RG's phonological impairment is investigated beyond a comparison of word and nonword reading so that the authors are able to reject the perceptual and expressive stages within the phonological route as loci of impairment and locate the impairment at the stage "that permits grapheme-phoneme correspondence". The nature of RG's phonological impairment is further investigated by Dérouesné and Beauvois (1979). RG and three other phonological dyslexics (JA, PH and MF) were presented with nonword stimuli which varied in graphemic complexity and phonemic difficulty. A double dissociation was observed. The performance of JA and PH was significantly affected by graphemic complexity and not by phonemic difficulty. The reverse pattern was observed in MF and RG. In fact all four patients performed somewhat better on graphemically simple stimuli but the difference did not reach significance for MF and RG.

A "graphemically complex" nonword is one which requires resegmentation as letter-sound correspondences are not one to one. In fact, all

Dérouesné and Beauvois' graphemically complex stimuli contained a vowel digraph. A nonword is phonemically difficult if it requires phonemic processing, that is if it is not homophonic with a real word. This variable is less easy to explain in the context of a standard model. Dérouesné and Beauvois describe this type of processing as leading to the utterance of syllables or clusters of syllables through the evocation of sounds of each phoneme (or clusters of phones)". According to this description it would appear to correspond to the blending stage in the extended standard model. However, if lexical and non-lexical routes operate independently, it is clear that even homophonic nonwords would need to pass through the blender before output. If this is a truly phonological effect it may be explained in terms of a strategy of approximate phonological access to whole-word phonology. In this case, a facilitatory effect of pseudohomophony would suggest that nonword reading difficulty is primarily an output problem due to inability to articulate phonological representations for nonwords since a phonological representation must presumably reach the response buffer and feed back into the oral word representation system where an approximate match is obtained. A difficulty with this account is the spared ability to repeat nonwords demonstrated by some phonological dyslexics who are sensitive to pseudohomophony (e.g. RG, Beauvois and Dérouesné, 1979). An alternative account has been suggested (Patterson, 1982; Coltheart, 1980c). This explains the effect as reflecting reliance on a strategy of approximate <u>visual</u> lexical access. This possibility was investigated by Martin (1982). Martin used a lexical decision task in which the degree of visual similarity of pseudohomophonic and non-pseudohomophonic nonwords to words was carefully controlled. She concludes that the pseudohomophone effect observed in normal readers in this task (e.g. Coltheart et al., 1977) in which the "No" response is slowed if the nonword is a pseudohomophone results from visual rather than phonological similarity. Martin used the same lexical decision task in a second experiment in which subjects were acquired dyslexic patients, one of whom (JS) was a phonological dyslexic. JS showed a similar effect to that shown by normal subjects, that is reaction time to non-pseudohomophones which were visually close to words was no faster than to visually close pseudohomophones while responses were faster when nonwords were visually distant from words. JS was apparently more efficient at reading aloud pseudohomophones (20% correct) than non-pseudohomophonic nonwords (15% correct) although in the absence of raw figures it is not possible to tell whether this difference was significant. Unfortunately the effect of degree of visual similarity on reading performance is not recorded. Nolan and Caramazza (1982) found that the effect of pseudohomophony on the nonword reading of their deep dyslexic patient BL was due to the closer visual similarity to words of the pseudohomophones. Dérouesné and Beauvois (1985) investigated the issue of pseudohomophony further with the phonological dyslexic LB. They found strong effects of both pseudohomohony and visual similarity on nonword reading, with the effect of pseudohomophony being significant for stimuli which were both high and low on visual similarity. However, this significant effect of pseudohomophony was only found when an instruction to try to use a homophonic strategy was given. This effect of experimental instructions makes the result somewhat difficult to interpret but the investigation does suggest that LB could use a homophonic strategy and thus could assemble non-lexical phonology to a limited extent under certain circumstances. Further supportive evidence is provided by the lack of an effect of the instruction to use a strategy of approximate visual access to the lexicon even though he was able to perform fairly well on a task which required him to produce a word which looked like the nonword. However, the majority (86%) of his error responses to nonwords which were words were visually similar to the target.

No firm conclusions can be drawn at present. Both pseudohomophony and visual similarity can affect nonword reading in phonological dyslexia; the relative importance of each and the consistency of effects across patients have not been established. In particular, there are patients who show no effect of pseudohomophony (PM, Bradley and Thomson, 1984; AN, Phillips et al., 1985, and Phillips, personal communication). This lack of effect suggests, not surprisingly, that different patients rely on different strategies for attempting to read nonwords. It has been demonstrated that PM, for example, relied on a strategy of approximate visual access followed by deletion of superfluous phonemes.

The most comprehensive investigation of a case of phonological dyslexia is that presented by Patterson (1982). Patterson discusses the case primarily in terms of the possible involvement of phonological coding in normal reading but nevertheless administered a range of tests of both word and nonword reading, many of which have been mentioned in earlier discussion.

Sartori et al. (1984) reviewed the cases of phonological dyslexia which have been reported since 1979. The patterns of impairment reported for these patients, several of whom have been discussed earlier in relation to theoretical issues are presented in Tables 2.1 - 2.4. Data from the case presented by Weisenburg and McBride (1935) and (1974) are also included in these tables, so also are data from AR (Warrington and Shallice, 1979) who was formerly classified as a deep dyslexic, PM (Bradley and Thomson, 1984), RIC (Kremin, 1984) and AN (Phillips et al., 1985) reports of whom were not available at the time Sartori et al. published their review. Data from four subjects who have been described as developmental phonological dyslexics are also included. Sources of reference for these patients are listed in Table 2.5. The variables "word frequency" and word length are included as column heads in Table 2.2. An effect of word length is not normally associated with phonological dyslexia (Patterson, 1981) but has been shown to affect the performance of 6 patients to a greater or lesser extent. Models do not predict such an effect within the direct or lexical-semantic routes and the issue is not discussed by the authors of these case reports. Possible explanations could be offered in terms of output problems - in articulating multisyllabic sequences or in deterioration of the phonological representation within the response buffer - or difficulties in early visual analysis or even sensory visual stages, possibly resulting from difficulty in containing lengthy stimuli within a reduced visual field (hemianopia is frequently reported in dyslexic patients). An effect of frequency is not a critical symptom of phonological dyslexia and its presence is not predicted by the nonword reading deficit. Nevertheless it is not implausible to suppose that frequently-used pathways between representations may be more resistant to damage if there is any lowering of efficiency of direct and/or lexical routes. Word frequency has been reported fairly widely as an important determinant of word reading success, for example, in concrete word dyslexia (Warrington, 1981) and dyslexia in the context of Wernicke's aphasia (Ellis et al., 1983).

Earlier arguments regarding the failure to identify symptoms which necessarily co-occur in phonological dyslexia are supported empirically by the variation in symptom patterns which is apparent from the tables. Table 2.1 shows all possible combinations of hemisphere and handedness although the most common pattern (occurring in at least 50% of reported cases) is of left hemisphere damage in dextrals. Of the four developmental cases reported, one is left- and one right-handed; handedness is not specified in the remaining cases. This pattern contradicts a claim made by Temple and Marshall (1983) that "a disproportionately high number of phonological dyslexics re left-handed." Aphasia may be fluent, nonfluent or absent; dysgraphia is usually present, although in varying degrees but is absent in one patient. All the variables included in Table 2.2 may affect performance in phonological dyslexia (Beatrice), alternatively none may affect performance (WB, although specific information regarding frequency and word length is not provided). It is worthy of note that there is no unequivocal evidence of dissociation between the occurrence of derivational errors (Table 2.3) and sensitivity to the presence of a suffix (Table 2.2), although Beatrice who was affected by the presence of a suffix on verbs made few derivational errors. WB was not sensitive to the presence of a suffix and made very few derivational errors; the majority of patients for whom this data is available were affected by the presence of a suffix and made derivational errors. It seems probable that if errors are genuinely derivational then affixed words should elicit more errors. This argument is complicated by the fact that affixed words tend to be visually similar to more real words; they are "not as discretely specified orthographically as are monomorphemic words of equivalent length" (Campbell and Butterworth, in press).

The number of occasions on which a patient is reported as making a very small number of semantic errors (5/22, 23% of acquired cases and 1/4, 25% of developmental cases) favours the notion that deep and phonological dyslexia are not distinct varieties of acquired reading disorder.

Table 2.1 Hemisphere damaged, handedness, aphasia and dysgraphia

Patient	Hemisphere damaged	Handedness	Aphasia	Dysgraphia
AM	R	L[a]	F	+
BTT	L	L	NF?	+?
GRN	?	R	F?	+
WB	L	?	NF	+
AL	?	?	F	?
JS	L	R	F	?
AR	L	R	F	-
PM	L	R	NF	+
AN	R[e]	R	F	+
Case 4	L	R[b]	NF	+[c]
RG	L	R	-	minimal
JA	L	R	+	+
PH	?	R	-	+
MF	L?	R	+	+
LB[d]	R	R	-	severe
RIC	L	R	NF	?
AMM	L	R	NF	+
Leonardo	R	R	NF	+
Beatrice	L	R	NF	+
Raffaella	L	R	F	+
Lucrezia	L	R	NF	+
HM		L	-	+
LT		?	-?	+
RE		R	-	some
Marco		?	-?	+

Notes for Table 2.1

a but wrote with his right hand having been told to do so at school
b This patient is "right-handed for all unimanual activities but takes left-handed position for all bimanual."
c although written spelling to dictation of single words was superior to that of normal subjects on difficult words.
The patient did however make "unusual errors in relatively familiar words"
d Some of the entries for LB in this table differ from those recorded by Sartori et al. (1984). Information is taken from the report by Dérouesné and Beauvois (1985), whereas Sartori et al. cite a conference paper presented by Dérouesné and Beauvois (1982).
e Although the infarction is in the right frontal region, there is evidence of diffuse vascular disease affecting the left as well as the right hemisphere.

L = Left
R = Right
F = Fluent
NF = Non-fluent

Throughout these tables:
+ = present, or presence of effect
- = absent, or absence of effect
? = data not available.

Table 2.2 Variables affecting word reading

Patient	Function/ Content	Noun/Verb[a]	Presence of suffix	Concreteness or Imageability	Frequency	Length
AM	+	-	+	-	-	-
BTT	?	?	?	-	-	?
GRN	?	?	?	?	-	?
WB	-	-	-	-	-?	-?
AL	+	?	?	+?	?	?
JS	?	?	?	?	?	?
AR	-	-	?	+	+	slight
PM	-	-	?	+	?	?
AN	+	-[c]	+	+	?	-
RG	+?	+?	?	?	?	-
LB	+	?	+	+	+	+
RIC	-	?	?	-	+	+
AMM	-	+	?	-	-	-
Leonardo	-	+	+	-	-	+
Beatrice	+	+[b]	+[b] on verbs	+	+	if 8 letters
Raffaella	-	+	?	-	-	+
Lucrezia	-	-	?	-	-	-
HM	-	?	?	+?	+?	-
LT	Longer latencies for function	?	?	on low frequency words	+	-?
RE	-	-?	-	-?	-?	-?
Marco	-?	+[b] on affixed verbs	+[b]	-?	-?	-?

Notes for Table 2.2

a Where an effect on this variable is recorded performance was superior on nouns

b All verbs in the verb lists on which these patients were tested were inflected. It is therefore not possible to decide whether the critical effect was of part of speech or presence of an affix.

c When verbs are uninflected reading of inflected verbs is severely impaired.

Case 4,JH, PH and MF are omitted from this table as all cells for these patients would have carried queries.

Table 2.3 Type of word reading error

Patient	Visual	Derivational	FWS	Semantic	Other	Omission
AM	few	+	+	1 possible	-	?
BTT	?	+?[d]	-?[a]	-	?	?
GRN	?	+?[a]	-?[a]	-	?	?
WB	+	+(vis)	2	5 (6% of total errors)	phonemic	?
AL	?	?	?	1	?	+
JS	-	-?	-?	-	neologisms	?
AR	+	+	+[b]	+ (5% of total errors)	?	?
PM	+	few	-	-	-	+
AN	+	+	+	6	phonemic paraphasias	+
Case 4	?	?	?	?	"mispronunciations" in text.	?
RG	+	+	+	-	?	+
LB	+	+	+	-	rare neologisms	rare
RIC	+	+	+(vis)	5[c]	neologisms	1
AMM	+	+	-	-	few neologisms	-
Leonardo	+	+	-	-[d]	?	few
Beatrice	+	few[e]	+	-	?	most
Raffaella		+	+	+(vis)	-	?few
Lucrezia M	+	+	+(vis	-	?	some
HM	+	+	-	-	few neologisms	?
LT	+	few	-?	2 poss.	few neologisms	?
RE	-	3	few (vis)	-	few neologisms	-?

Notes for Table 2.3

a Implied in discussion by Patterson (1982)

b Information obtained from the authors by Coltheart (1980b)

c In fact, Kremin concludes that there were fewer than 5 "true" semanti errors since all but one bore some visual similarity to the target.

d When tested 2 weeks post-trauma Leonardo did in fact make a number of semantic errors. 4 weeks later his pattern of reading impairment had altered andsemantic errors were no longer made.

e Sartori et al (1984) record no derivational errors for Beatrice but note that "she did make 14 errors that may be classified as derivational (in that they had the same root morpheme) but only to verbs".

(vis) most errors were also visually similar. The absence of this note doe not imply that errors were visually dissimilar. This information is frequently not available.

FWS Function word substitution.

JA, PH, MF and Marco are omitted from this table as all cells for these patients would have carried queries.

Table 2.4 Type of nonword reading error and performance with different types of stimuli.

Patient	Lexical-isations	Incorrect nonwords	Omissions	Effect of Pseudo-homophony	Effect of graphemic complexity[a]	Able to sound single letters[b]
AM	most	+	few	+	?	none
BTT	+	?	?	?	?	?
GRN	+	+	+	?	?	-
WB	+	1	many	-	?	none
JS	?	?	?	+?[c]	?	?
AR	?	?	?	?	?	-
PM	few	-	most	-	?	none
AN	few[f]	mainly	?	-	-	?
Case 4	+?	+[d]	?	?	?	-
RG	+[e]	?	?	+	-	?
JA	?	?	?	-	+	?
PH	?	?	?	-	+	?
MF	?	?	?	+	-	?
LB	+	most	few	+	+	+
RIC	most	+	?	?	?	?
AMM	+	+	-	?	?	?
Leonardo	+	+	?	?	?	?
Beatrice M	-	-	all	-	-	?
HM	most	+	-	+	?	+
LT	some	most	-	+ (on response latencies)	+	?
RE	few	+	?	-	?	-
Marco	most	?	?	?	?	?

Notes for Table 2.4

a as defined by Dérouesné and Beauvois (1979)
b + = spared ability, - = impaired ability
c It is not clear from the case report whether or not this effect is significant. A significant effect was obtained on a lexical decision task.
d In fact only two examples are given, of which one is a lexicalisation of the other incorrect nonword. It is probable, however, that unique error types would not have been chosen as examples.
e In the examples given RG was aware that the word respones were only approximations to the correct responses, e.g. VINA -- "c'est presque vinaigre".
f All lexicalisations are recognised as errors and rejected by AN.

AL, Raffaella and Lucrezia are omitted from this table as all cells for these patients would have carried queries.

Table 2.5 Sources of reference for patients for whom data appears in Tables 2.1 - 2.4.

English

AM	Patterson (1982)
BTT	Shallice and Warrington (1980)
GRN	" " " "
WB	Funnell)1983)
AL	Allport and Funnell (1981)
JS	Martin (1982)
AR	Warrington and Shallice (1979)
PM	Bradley and Thomson (1984)
AN	Phillips et al. (1985)
Case 4	Weisenburg and McBride (1935)

French

RG	Beauvois and Dérouesné (1979)
JA	Dérouesné and Beauvois (1979)
PH	" " " "
MF	" " " "
LB	Dérouesné and Beauvois (1985)
RIC	Kremin (1984)

Italian

AMM	DeBastiani et al. (1983)
Leonardo	Job and Sartori (1984)
Beatrice	Sartori and Job (1982)
Raffaella	Sartori et al. (1984)
Lucrezia	" " " "

Developmental Cases

English

HM	Temple and Marshall (1983)
LT	Seymour and MacGregor (1984)
RE	Campbell and Butterworth (in press)

Italian

Marco	Sartori and Job (1982)

NOTES FOR CHAPTER 2

1 This, like the definition of phonological dyslexia, is an over-simplified "working definition". Observed problems and alternative interpretations are discussed in Patterson, Marshall and Coltheart (1985).

2 This discrepancy between word and nonword reading has also been reported in the developmental surface dyslexic CD (Coltheart et al., 1983) who read 90% regular words correctly while her success rate with nonwords was as low as 23%. This pattern is by no means typical of surface dyslexia. For example, Deloche et al., (1982) report that their patient, AD, performed better on nonword than on word tests.

3 Morton and Patterson (1980) also consider the possibility that the Early Visual Analysis system is implicated but reject this possibility on the basis of the bias towards the production of word rather than nonword responses, the efficiency with which some patients perform on the lexical decision task and the relative indifference to the quality of the visual display which is evident in the performance of a number of deep dyslexic patients.

4 Patterson (1982) notes that this class of words is "rather loosely defined" and includes "prepositions, conjunctions, pronouns, articles, auxiliary verbs, and certain adverbs and adjectives".

5 There is some doubt whether the effects on performance are due to varying the concreteness or the imageability of the stimuli since the two are highly correlated. Patterson and Marcel (1977) provide some evidence that imageability is the relevant variable.

6 The symptoms which Coltheart (1980b) argues constitutes the symptom-complex of deep dyslexia are as follows:

1. Semantic errors
2. Visual errors
3. Function-word substitutions
4. Derivational errors
5. Non-lexical derivation of phonology from print impossible.
6. Lexical derivation of phonology from print impaired.
7. Low-imageability words harder to read aloud than high-imageability words.
8. Verbs harder than adjectives which are harder than nouns in reading aloud.
9. Function words harder than content words in reading aloud.
10. Writing, spontaneously or to dictation, is impaired.
11. Auditory-verbal short-term memory is impaired.
12. Whether a word can be read aloud at all depends on its context.

Chapter 3

TESTING MATERIALS AND ERROR CLASSIFICATION

3.1 Testing Materials

The majority of tests have been administered to all ten patients of whom detailed case reports are provided in Chapter 4. Tests have been omitted when limited time was available for testing the patients or exceptionally, when a high failure rate on an easier test in which the same variables were manipulated predicted a very low success rate on the test. If only two words in a set of twenty or so items are read correctly, the test does not contribute to an understanding of the effect of a given variable on the patient's reading performance. Error responses can, of course, be analysed but the advantage of an expanded error corpus is outweighed by the disheartening effect on patients of presenting them with tests which are quite beyond their capabilities. Tests of nonword reading were the exception to this rule. They were administered even when failure rates were very high. It was explained where appropriate, that these tests tapped a very specific subskill which was possibly not related to other reading abilities. The rationale for a number of the tests has been discussed in connection with possible symptoms of phonological dyslexia and where this is so only brief comment will be made in this chapter. A composite list of all tests administered is provided on page 161.

3.1.1 Neuropsychological background tests

A number of published tests were administered in order to provide some indication of the patient's level of ability on tasks which did not involve reading. These tests are:

3.1.1 The Boston Diagnostic Aphasia Examination (BDAE) (Goodglass and Kaplan, 1983; 1971)

The value of assigning patients to one or other variety of aphasia within the classical taxonomy has been queried (see earlier discussion). In the case reports the pattern of an aphasic impairment will be discussed briefly and a syndrome label applied only for shorthand purposes for use in tables. Some patients have been tested with the first and others the second edition of the BDAE. As no major test revisions appear in the second edition, scores obtained using either edition remain comparable with those obtained using the alternative edition. The test has the further advantage of being sensitive at high performance levels but its length makes it unsuitable for use with some patients who are very severely aphasic. All but one (IC) of the patients with whom I worked were able to work through the Boston. IC was assessed using the Aphasia Screening Test (Whurr, 1974). Tests involving non-linguistic (spatial and computational) skills were not normally administered.

3.1.1.2 Boston Naming Test (Kaplan et al., 1983)

This test supplements the Visual Confrontation Naming subtest of the BDAE.

3.1.1.3 **Wechsler Memory Scale** (Wechsler and Stone, 1948)

This test yields a memory quotient which in itself is of limited value since the subtests included in the scale tap different memory processes and there is additionally a substantial language component in certain tasks. Nevertheless, it is useful as an indicator of whether or not there is any memory impairment.

3.1.1.4 **Token Test (shortened version)** (De Renzi and Faglioni, 1978)

This test is widely used to test comprehension of auditorily-presented material. Efficient performance depends on the comprehension of prepositional relationships. However, the complex instructions contained in later sections of the test have a strong memory component (Albert et al., 1981) and a low score could result from an auditory memory deficit or difficulty in comprehending grammatical relations or from a combination of the two. The shortened version of the test contains 36 items.

3.1.1.5 **Peabody Picture Vocabulary Test** (Dunn, 1965)

The test provides an estimate of verbal intelligence by measuring comprehension of single auditorily-presented words. A pointing response is an acceptable substitute for an oral response and all patients were instructed to make pointing responses in order to avoid possible number confusions resulting from their aphasic difficulties. There are two forms of this test. From A was used in a standard auditory administration of the test. A written version of the test in which stimuli were presented stencilled on card was also administered using Form B.

3.1.2 Reading Tests

It is now generally accepted by reading researchers working within the current neuropsychological tradition that a set of variables likely to affect the reading performance of acquired dyslexic patients may be identified (e.g. Patterson, 1981). Over the last decade, a number of tests based on manipulation of these variables have been developed. One aim of the tests is diagnostic; they should enable the neuropsychologist to assign a patient to one or other of the diagnostic categories discussed earlier. Although the value of such diagnosis has been queried, these tests are essential for preliminary analysis of the reading disorder. Where diagnostic tests have already been developed and are readily available, they have been used. Sources are noted in each case; a large proportion are due to Coltheart (1981b). Otherwise new tests have been devised. (This is indicated by an asterisk following the test title). Tests of nonword reading currently available are too crude to be useful in identifying the precise nature of the impairment. The majority of nonword reading tests used are therefore new tests which have been constructed with the aim of testing the operation of different subsystems within the phonological route.

Where tests were developed for use with only 1 or 2 patients to investigate specific aspects of performance not appropriate for investigation in other patients, these tests are described in the individual case report and not in this chapter.

Unless otherwise stated, letters, words and nonwords were stencilled individually on white card using black ink and a "Billographe" No. 10 stencil (lower case) and presented to the patient in random order.

3.1.2.1 Letter level

3.1.2.1.1 Single letter naming.

Wernicke and Weisenburg (see Benson and Geschwind, 1969) have both distinguished forms of dyslexia in which the ability to read letters is lost from forms in which letters can be read but whole words cannot. This distinction is applicable to the current taxonomy inasmuch as single letter identification is a prerequisite for reading in surface and letter-by-letter dyslexia but need not be so in deep and phonological dyslexia. Spared letter naming-performance in conjunction with a loss of ability to sound single letters is frequently found in phonological dyslexia; in cases which have been assigned to the deep dyslexia category, letter naming itself is often impaired. Perfect performance on single letter reading combined with poor ability to read single letters from a string suggests an attentional problem (Coltheart, 1981) in which target letters or words cannot be efficiently distinguished from accompanying letters or words.

All 26 letters of the alphabet were used.

3.1.2.1.2 Single letter sounding.

Twenty four letters of the alphabet (q and x being omitted) were presented with the instruction to give the sound of the letter. Further explanation was given if the patient appeared not to understand the task.

3.1.2.1.3 Single letters from a string

Twenty randomly-generated strings of three letters were used, the patient being asked to name the middle letter in each case.

abd	crp
drp	duz
tuv	flm
cpl	nro
exo	gst
hij	aeh
qkw	ikj
yma	dzl
tuz	mnt
gbr	btl

3.1.2.1.4 **Cross-case letter matching** (Coltheart, 1981b).

The aim of this test is to see whether the patient can judge that 2 letters are the same even when they differ in case and are visually dissimilar. Inability to name letters may be a facet of nominal aphasia, but inability to match letters would indicate a failure in recognition resulting from damage to the abstract letter identification system.

Items prepared by Coltheart (1981b) were used. Coltheart notes that only letters which are very different in their upper and lower case forms were used to generate the stimuli, namely the six letters A, D, E, G, N, R. Fifty-eight cross-case letter pairs were stencilled on card and the patient asked to respond "same" or "different" according to whether members of the pair represented the same or different letters.

aA	Ne	nN	Ge	De	nN
gG	An	eE	Ea	gG	gG
Da	eE	aA	Nn	rR	Gg
Gg	Aa	dD	Ag	Ar	Nn
Gr	Nr	Rr	Dg	Ad	Eg
dD	Dd	Gn	Ee	Na	Dd
rR	Ee	Re	Dr	Ae	Aa
Nn	Er	Aa	Gd	Rr	eE
Rd	Ra	Ga	Dn	En	
Ng	Rn	Ed	Rg	Nd	

3.1.2.2 **Single word level**

3.1.2.2.1 **Easy Lexical Decision** (Coltheart, 1981b).

The ability to judge whether or not a printed letter string is a word indicates that the visual word recognition system at least is operational. Lexical decision may in some cases involve the semantic system (see Chapter 1, Section 1.3.1.2.1).

Stimuli are 25 short, high frequency nouns and 25 nonwords selected by Coltheart (1981). Nonwords were generated by altering one letter of a short, high frequency noun. Patients were asked to respond "Yes" if they thought the stimulus was a word and "No" if they thought it was a not a word.

Words	Nonwords
house	bem
hand	walp
money	cridge
street	doard
room	kun
school	parsy
fire	cabe
woman	plafe
church	gog
floor	balt
head	piver
eye	koe
car	squate
book	bife
city	dight
boy	mome
road	haper
table	poom
man	nove
child	rame
door	tround
girl	stape
face	cown
water	farl
food	clut

3.1.2.2.2 **Difficult lexical decision** (Coltheart, 1981b)

All words used in this test have more than 11 letters, 5 or more syllables, were of low frequency and were relatively abstract in meaning. Nonwords were generated by interchanging two syllables of a word. The test contains forty items, twenty words and twenty nonwords and was administered in the same way as the easy lexical decision test.

Words	Nonwords
imperceptible	electrifationic
miscalculations	cannistibalic
inappropriateness	dimeocrities
belligerently	imparsonious
presupposition	comormemating
categorically	cirsemicular
overconfident	ramifationic

prototypical	compatibinility
dissatisfactions	algenerities
existentialism	logibiocally
repudiating	exaggationers
procrastination	lumilinations
recapitulate	incocidental
disorderliness	laborcolator
humiliatingly	habinitation
municipality	cenectricities
confederations	gracontulation
disproportionately	reostephonic
undemocratic	forgivunable
linguistically	lucinhallations

3.1.2.2.3 **Imageability (standard)** (adapted from Coltheart, 1981b).

Imageability (see Chapter 2, Note 5) is a semantic dimension of words and sensitivity to variations in imageability are evidence of reliance on the lexical-semantic route.

Coltheart's test contains 28 high-imageable and 28 low-imageable words matched for word frequency and for number of letters, syllables, morphemes and vowels. The test was shortened slightly to contain a total of 40 items. Pairs of items which were of very low frequency (1-10 according to the Thorndike-Large (1944) count) were removed, selected pairs being used in the composition of a more difficult version of the test, and 4 pairs of more frequent items substituted.

Low-imageable	High-imageable
fact	hand
moment	office
reason	street
idea	book
amount	person
method	letter
average	student
truth	blood
attitude	hospital

soul	skin
promise	journal
origin	oxygen
fate	gift
folly	angle
topic	cigar
hint	moss
event	apple
excuse	engine
reminder	musician
democracy	landscape

3.1.2.2.4 **Imageability (difficult)***

Twenty high imageable and twenty low imageable nouns of low frequency (1-10 in the Thorndike-Lorge (1944) count) were selected. High and low imageable items were matched for word length (all items were of 7 or more letters in length) and, as closely as possible, for syllable length. A word was classed as high-imageable if it had a rating greater than 5 in the Paivio et al. (1968) scales and as low-imageable if it was rated at less than 3.

High Imageable	Low Imageable
pianist	concept
acrobat	essence
blister	fallacy
outsider	aptitude
busybody	emporium
accordian	criterion
vestibule	deduction
amplifer	exclusion
horsehair	disparity
lubricant	increment
infirmary	unreality
medallion	franchise
camouflage	disclosure
gymnastics	unbeliever
metropolis	inducement
microscope	discretion
photograph	competence
cobblestone	elaboration
connoisseur	impropriety
vaccination	ingratitude

Mean imageability - 5 9	Mean imageability - 2.5
Mean frequence - 2.85	Mean frequency - 2.7
Mean number of syllables - 3.2	Mean number of syllables - 3.45

3.1.2.2.5 **Part of Speech (easy)** (Warrington, 1981)

The test consists of twenty high frequency (AA in the Thorndike-Lorge count) nouns, verbs, adjectives and function words.

Nouns	Verbs	Adjectives	Function Words
lip	love	able	against
pony	follow	narrow	if
battle	shall	south	up
table	win	deep	on
paper	been	free	in
dog	beat	due	but
boy	press	hot	along
farm	born	open	beside
queen	want	good	over
woman	has	young	and
letter	bring	big	upon
egg	went	dark	his
number	pray	natural	she
husband	enjoy	fresh	you
brother	pass	old	he
time	wonder	fifty	them
iron	began	little	myself
ice	happen	warm	whose
moon	do	busy	hers
plant	found	bright	herself

3.1.2.2.6 **Part of speech (difficult)***

Twenty nouns, verbs, adjectives and function words, of fairly low frequency (Thorndike-Lorge counts of 1 - 35) and 6 or more letters in length were selected. Items were matched as closely as possible for frequency, number of syllables and word length.

Nouns	Verbs	Adjectives	Function-words
platinum	conceive	discreet	hitherto
dimension	officiate	concerned	howsoever
parchment	harmonise	civilised	whichever
glimmer	discard	haughty	whither
gladiator	discern	plausible	whosoever

	compassion	dishearten	concentric	whatsoever
	hatchet	dislike	hostile	whereby
	rainbow	portray	furious	whereas
	rapture	dismiss	gallant	thereby
	utensil	impress	awkward	thereof
	parsonage	fascinate	classical	thereupon
	runway	pierce	placid	herein
	rubber	pickle	dismal	hereby
	loneliness	popularise	complacent	henceforth
	luncheon	diminish	gigantic	hereupon
	mushroom	venerate	luminous	herewith
	plantation	rehabilitate	horizontal	heretofore
	standardisation	misunderstand	unsophisticated	notwithstanding
	placard	imprint	pompous	betwixt
	pioneer	indulge	wealthy	whereof
mean frequency	10.6	10.75	10.85	11.15
mean no. of syllables	2.65	2.65	2.7	2.65
mean word length	8.3	8.3	8.3	8.3

3.1.2.2.7 **Part of speech (revised)***

This version of the part of speech test systematically varies word length on which high frequency (AA or A) nouns, verbs, adjectives and function words are matched. Items are also matched for regularity of spelling. The test was originally developed for use with surface and letter-by-letter dyslexics but has been useful in cases of deep and phonological dyslexia since word length occasionally affects performance in the latter as well as the former types of acquired dyslexia. The verb section includes forms of the verb "to be" and the auxiliary verb do which are better classified as functors. When comparing performance on different parts of speech, the following are counted as function words: am, is, be, do, has, been, shall.

Nouns	Verbs	Adjectives	Function Words
	go		if
	am		up
	is		on
	be		me
	do		he
dog	see	due	but
tie	has	low	too
oil	sit	big	for
son	ask	old	who
eye	buy	one	you
farm	seem	free	them
time	help	dark	hers
hand	been	near	down
soul	want	busy	your
shoe	come	warm	what
value	shall	fresh	along
shore	press	black	under
thing	bring	first	their
blood	laugh	heavy	below
money	break	young	which
garden	arrive	little	beside
battle	happen	single	around
number	travel	narrow	itself
health	honour	pretty	behind
friend	should	double	though
husband	attempt	western	without
problem	support	natural	between
teacher	explain	outside	herself
brother	measure	various	whether
thought	control	English	anybody

3.1.2.2.8 **Regularity of spelling (standard)** (Coltheart, 1981b)

A correct phonological representation can be obtained for regular words through the application of grapheme-phoneme conversion rules. If irregular (exception) words are read by this method an incorrect phonological representation will be produced. When patients are unable to use the phonological route there should be no effect of regularity of spelling. The issue of what constitutes regularity of spelling has recently been reassessed in the light of the different judgments of regularity which result from consideration of spelling units larger than the grapheme (e.g. Shallice et al., 1983) and the importance of inconsistency as opposed to simple irregularity (Glushko, 1979). The majority of the regular words in this test are also consistent, with a few exceptions (e.g. treat; save), a few irregular words could be considered regular if larger units of conversion are proposed (e.g. sign). Although the test would need reassessment in the light of recent discussion if it were to be used in any detailed study of surface dyslexia, it remains a useful preliminary test which should elicit some regularisation errors and differential performance on the two types of stimuli in patients who are relying on the phonological route to reading.

The 39 regular and 39 irregular words are matched for length, number of syllables, part of speech and word frequency.

Irregular	Regular
gauge	grill
gaunt	gang
laugh	treat
break	dance
steak	slate
debt	cult
pint	pine
sign	base
mortgage	distress
castle	sherry
come	take
glove	spade
love	turn
shove	shrug
lose	save
move	sort
prove	spend
gone	kept
gross	quick
bury	duel
borough	capsule
thorough	splendid
scarce	strewn
answer	county
sword	spear
yacht	trout

sure	free
blood	horse
flood	tooth
cough	barge
trough	throng
bowl	plug
soul	mile
build	check
biscuit	shampoo
circuit	protein
subtle	stupid
sew	rub
broad	fresh

3.1.2.2.9 **Regularity of spelling (difficult)***

Regular and irregular nouns of low frequency (< 35 in the Thorndike-Lorge count) were selected for this test. Items are matched for frequency, word length, number of morphemes and number of syllables. Regularity of spelling was judged in terms of the rules explicated by Wijk (1966). The test contains 20 regular and 20 irregular items.

Regular	Irregular
alcove	rhythm
strand	scythe
turnip	memoir
landing	heiress
mastiff	stomach
muffler	worsted
peacock	bouquet
starter	chronic
tribute	chassis
yearling	poultice
lemonade	concerto
parasite	designer
scoundrel	moustache
stripling	champagne
thickness	bourgeois
boomerang	chronicle
grenadier	archangel
condiment	psychosis
misfortune	lieutenant
switchboard	draughtsman
mean frequency - 6.35	mean frequency - 6.25

3.1.2.2.10 Frequency*

Published reading tests of graded difficulty are available which contain very low frequency words (e.g. Schonell, 1942). Such tests do not normally control imageability and are unsuitable for testing sensitivity to word frequency for this reason. A further disadvantage is that the very difficult words in such tests may never have formed part of the patient's sight vocabulary. Failure on these words could then simply reflect pre-trauma reading standard rather than impairment consequent on cerebral injury. Low frequency (<40 on the Thorndike-Lorge count) words on this test were selected with this in mind as words which an average or even poor reader would have been likely to have within his sight vocabulary. High frequency words have AA or A ratings and items are matched for imageability and word and syllable length.

HF	LF
sky	fox
boy	keg
lad	ink
book	mast
love	lump
meat	harp
camp	dove
cost	dell
amount	belief
earth	plank
dream	quest
storm	skull
board	spray
letter	kettle
butter	barrel
doctor	beggar
garden	hammer
person	bandit
teacher	tempest
picture	monarch

machine	profile
village	lobster
opinion	edition

3.1.2.2.11 **Word length***

The test contains 60 words ranging from 3 to 8 letters in length, 10 words appearing in each length set. Items differing in length are matched for frequency and part of speech across lists. Words were presented in lists of 5, each word in the list being of the same length. Lists were presented in random order. Each patient was instructed to read all 5 words aloud as rapidly as possible and not to correct any response which (s)he felt was incorrect. Reading of each list was timed with a stopwatch and the mean time per word calculated.

	List 1	List 2
3-letter	tag	bug
	sly	sad
	cab	rut
	sky	tin
	lad	log
4-letter	rust	tact
	stud	sane
	flat	sock
	plot	rock
	lamp	flag
5-letter	scarf	crest
	blunt	thick
	sprig	stunt
	stone	pluck
	shock	plane
6-letter	tavern	gallon
	sullen	hollow
	butler	thrift
	length	timber
	custom	burden
7-letter	blister	duchess
	drunken	correct
	monster	capsule
	loyalty	partner
	torture	factory

8-letter	bulletin	tapestry
	splendid	stubborn
	lemonade	ministry
	distress	industry
	hospital	attitude

3.1.2.2.12 Presence of Suffix I*

This test contains 60 high frequency (AA) words. Appropriate suffixes have been added to 30 of the words, suffixed and non-suffixed words are matched for part of speech. Suffixes used signal comparative and superlative forms (-er, -est), plural form (-s), past tense (-d, -ed)and gerundial (or continuous verbal) form (-ing). This test was included because of a) the desirability of having an easier test of sensitivity to the presence of a suffix since the complexity of some of the non-suffixed words in the following test tend to make it a difficult test, beyond the capabilities of a few patients and b) the possibility that the frequency of the root morpheme affects performance on suffixed words (Bradley, 1980) in which case suffixed words would in fact be of higher frequency than their non-suffixed matches and a facilitatory effect of frequency might counterbalance the added difficulty caused by the presence of a suffix.

Non-suffixed	Suffixed
dark	deeper
near	richer
first	sweeter
low	hotter
cold	higher
fresh	greatest
south	youngest
warm	thinnest
free	nicest
bright	strongest
dog	cats

hat	days
shore	houses
face	hands
garden	numbers
problem	teachers
battle	tables
husband	brothers
shoe	coats
mouth	things
come	loved
bring	pressed
help	prayed
arrive	enjoyed
happen	travelled
follow	wondering
beat	wanting
support	attempting
explain	controlling
speak	breaking

3.1.2.2.13 Presence of Suffix II*

This test contains 28 suffixed and 28 suffixed and 28 non-suffixed words matched for word frequency, part of speech (adverbs being matched with adjectives), word length number of syllables and number of morphemes. Suffixes signal adverb formation (-ly), noun formation (-ness, -er), adjective formation (-y, -ous, -able), verb formation (-en), past tense (-d, -ed) and gerundial (or continuous verbal) form (-ing).

Non-suffixed	Suffixed
backward	safely
clever	slightly
genuine	sincerely
venison	awkwardness
cuckoo	cleaning
anchor	learning
paradise	proceeding
cucumber	flatterer
jargon	doings
anecdote	islander
sparse	spilt
blunt	cracked
drastic	slimy
adroit	valued
grotesque	touching
manifest	decided
insipid	laudable

torrid
sedate
obscure
circumspect
obscene
grapple
preside
adapt
polish
clamber
detect

lengthy
sickly
crowded
hazardous
piercing
deafen
lighten
harden
soften
flatten
straighten

3.1.2.3 Reading Text*

Several patients had severe difficulties with reading text and a passage was written which used fairly simple sentence constructions and a simple vocabulary but was not too childish in content. Since performance on function words in text is of interest in this study, the passage contains a high proportion of function words (54%). Patterson (1982) has noted that the class of function words is "loosely-defined" and includes "prepositions, conjunctions, pronouns, articles, auxiliary verbs, and certain adverbs and adjectives." Words used in the passage are therefore listed under the headings "content" and "function" in order to clarify their classification.

A Weekend Visit

Bob and Mary came to stay for a weekend. We went to meet them by car. We were rather late arriving at the station and had to run up the steps to the platform. The train had already arrived. Bob waved to us through the crowd. We showed them round the town. We visited the shops. They bought souvenirs. Mary got a silver ashtray. Bob chose a pen. Then we all drove home. Bob and Mary admired our new house. They liked their bedroom which looked out over the garden.

The next day was Sunday. We saw the cathedral and the ruined castle. The weather was fine. We enjoyed ourselves. They left in the evening. They thanked us and asked us to visit them soon.

Content n = 45	Function n = 69
Bob	and
Mary	to
came	for
stay	a
weekend	We
went	to
meet	them
care	by
late	We
arriving	were
station	rather
run	at
steps	the
platform	and
trained	had
arrived	already
Bob	to
waved	up
crowd	the
town	to
showed	the
visited	the
shops	had
bought	to
souvenirs	us
Mary	through
silver	the
ashtray	We
Bob	them
chose	round
pen	the
drove	we
home	the
Bob	they
Mary	got
admired	a
new	a
house	then
liked	we
bedroom	all
looked	and
garden	our
day	they
Sunday	their
saw	which
cathedral	out
ruined	over
castle	the
weather	the
fine	next
enjoyed	was
left	we
evening	the
thanked	and

asked	the
visit	the
	was
	we
	ourselves
	they
	in
	the
	they
	us
	and
	us
	to
	them
	soon

3.1.3 Comprehension Tasks

3.1.3.1. **Synonym matching** (Coltheart, 1981b).

The test comes in two forms, one using high-imageable and the other low-imageable words. The two versions are approximately matched for word length, frequency and degree of synonymity and performance on the two forms can therefore be compared.

Pairs of synonymous and pairs of non-synonymous words (19 high-imageable and 19 low-imageable pairs) were stencilled on card. The patient was asked to assign each card to a pile according to whether the two words on the card were the same or different in meaning. Piles were labelled <u>same</u> and <u>different</u> in order to avoid confusion of piles. Patients were encouraged to respond "same" if the two words were even approximately the same in meaning since, as Coltheart notes, exact synonyms are rare in English.

The words used in this test were also stencilled individually on card without duplication and presented in random order for reading aloud.

The reading aloud test was administered following the synonym matching task, after a brief rest interval. No comment regarding the use of the same word set was made. Comparison of the results of the reading and the matching tasks were made for each patient. Since all patients were impaired in their ability to assemble phonology, there is little likelihood that discrepancies in success rates on the 2 tasks are to be attributed to the use of the phonological route in reading aloud. This is especially true since all patients had extreme difficulty with (and several were unable to attempt) the reading of long words (e.g. in reading aloud items from the Difficult Lexical Decision Test, listed in Section 3.1.2.2.2). The words used in the synonym matching test included a proportion of long words (up to 12 letters in length), average word length being 6.1 letters. Therefore a word reading score which significantly exceeds the comprehension score is indicative of the functioning of the direct route. Ideally such a comparison would utilise tests using irregularly spelled words. Unfortunately it is extremely difficult to construct a synonym matching test composed of irregularly spelled words. The number of reasonably close English synonyms is limited and perusal of lists of word pairs rated for synonymity (Whitten et al., 1979; Wilding and Mohindra, 1981) shows that pairs in which both members are clearly irregularly spelled are too few to allow construction of a test. If only irregular members of the pairs were included in the reading test, inferior performance on the matching task could result from failure to comprehend the other (regular) member of the pair. It should be noted that Coltheart's test includes at least 6 exception words (tomb, ocean, marriage, menace, discovery, vestige, and several longer words with uncharacteristic stress patterns (e.g. impotence, reality).

High-imageability version

Synonymous Pairs		Non-synonymous Pairs	
tool	implement	tool	crowd
story	tale	story	implement
grave	tomb	grave	blossom
shovel	spade	shovel	tale
throng	crowd	throng	spade
ocean	sea	ocean	donation
flower	blossom	flower	boat
gift	donation	gift	sea
marriage	wedding	marriage	lamp
ship	boat	ship	tomb
rope	cable	rope	wilderness
desert	wilderness	desert	cable
battle	fight	battle	crop
grin	smile	grin	money
lantern	lamp	lantern	wedding
joy	happiness	joy	bag
harvest	crop	harvest	smile
cash	money	cash	fight
sack	bag	sack	happiness

Low imageability version

Synonymous Pairs		Non-synonymous Pairs	
lie	falsehood	lie	vestige
idea	notion	idea	security
despair	hopelessness	despair	consent
mockery	ridicule	mockery	notion
menace	threat	menace	luck
safety	security	safety	ridicule
pity	compassion	pity	falsehood
trace	vestige	trace	hopelessnes
agreement	consent	agreement	discovery
chance	luck	chance	threat
irony	sarcasm	irony	kingdom
blame	reproach	blame	counsel
reality	truth	reality	sarcasm
detection	discovery	detection	weakness
pardon	forgiveness	pardon	plan
advice	counsel	advice	forgiveness
realm	kingdom	realm	compassion
scheme	plan	scheme	reproach
impotence	weakness	impotence	truth

3.1.3.2 Semantic Probe (Funnell, 1983)

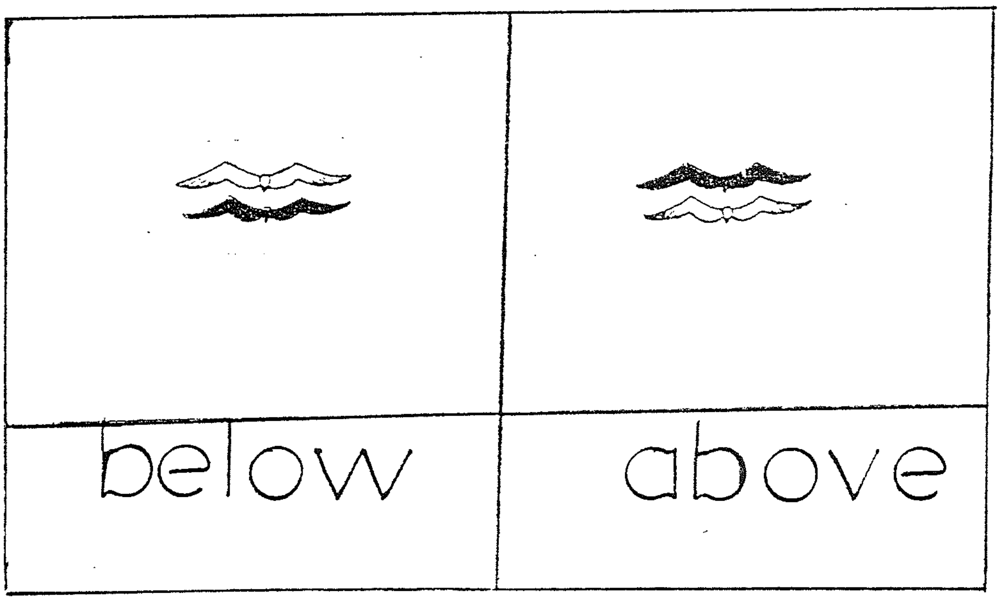
Sixteen pairs of related words were matched for syllable length and as closely as possible for word frequency. An additional probe word was selected which was more closely related to one word of the pair than to the other. This word tended to be of lower frequency than either member of the word pair. Funnell's original task has two forms. In one form word pairs are closely related, in the other they are unrelated. Only the first form is used here as a test of comprehension for which, because of the closeness in meaning of all words in the triad, a complete (or almost complete) semantic entry must be obtained.

The triads were stencilled on white paper with the probe divided from the related pair by a solid line. Patients were asked to underline the member of the word pair which was closest in meaning to the probe.

Probe	Related word pairs
mitten.	sock, glove
broom.	brush, comb
ladle.	spoon, fork
tack.	screw, nail
motorway.	road, lane
cradle.	bed,cot
serpent.	worm, snake
basin.	bowl, plate
sundial.	watch, clock
canoe.	boat, ship
loch.	lake, pond
bough.	twig, branch
tangerine.	orange, lemon
linen.	cotton, nylon
ale.	wine, beer
toast.	cake, bread

3.1.3.3 Comprehension of functors (based on Morton and Patterson, 1980b)

This test investigates comprehension of function words which involve spatial relationships and can be depicted pictorially and of the plural s on which so many errors are made by acquired dyslexic patients. The simple drawings of 2 or 3 objects in some spatial relationship to one another used by Morton and Patterson are included in the test but are used in a different manner. Each drawing appears twice on the same card. In each case one of the objects is coloured red in one picture while the other object is coloured red in the other picture. (Both figures are, or neither figure is coloured red in the drawings which accompany the together-apart word pair). Twelve function words are stencilled individually on card and are presented individually with the appropriate picture pair. Patients were asked to point to the picture in which the object coloured red matched the word. Demonstrations of the task were given using drawings representing the word pairs big/little and girl/boy. (Although the task is somewhat difficult to explain verbally, patients seemed to grasp what was required of them very quickly when they were shown the demonstration cards). In the case of plurals, drawings show either a single object or a group of 2 or 3 objects. Singular and plural forms of the appropriate words were presented with a picture pair and the patient again asked to print to the picture which matched the word. A specimen picture card is shown below.



The verbal stimuli used are as follows:

Function words	Singular and Plural Forms	
below	house	houses
before	plane	planes
over	car	cars
there		
together		
front		
above		
after		
under		
here		
apart		
behind		

3.1.4 Tests of morphological knowledge

Many phonological dyslexics have difficulty in reading aloud inflected words. This test was aimed at establishing whether or not knowledge of the significance of the presence or absence of an inflection within the morphological system of English is retained. The test contains 32 verbs, 16 in the form of the present tense (e.g. build and 16 in the past form (e.g. enjoyed). In each case 8 verbs were regular in their formation of the past tense and 8 were irregular. All verbs were of high frequency in their infinitive forms, (A or AA in Thorndike-Lorge). The order of items was randomised and the list of items handwritten (lower-case, non-cursive) on a sheet of paper. Patients were told that the paper showed a list of verbs or "doing-words" and that some of them were in a form suitable for use in sentences about the present - sentences about things happening now - while others were in a form suitable for use in sentences about things that had happened in the past. It was stressed that this was not a semantic task and that it was of no importance whether or not they personally had done or were doing any of the things. Their attention was drawn to the form of the words. Examples of present and past forms were given in the course of the explanation. Patients were then asked to tick all verbs which should be used in sentences about the past, leaving blank all those which should be used in sentences about the present.

Regular verbs in present tense	Irregular verbs in present tense
walk	write
hope	say
judge	build
call	find
clean	sit
work	eat
wash	tell
shout	give

Regular verbs in past tense	Irregular verbs in past tense
stepped	ran
followed	thought
enjoyed	sang
wondered	drove
cooked	rode
wanted	knew
helped	drew
loved	drank

3.1.5 Tests of nonword processing

3.1.5.1 Reading aloud easy lexical decision (Coltheart, 1981b)

In reporting a dissociation between word and nonword reading abilities most authors have reported percentages correct on the two types of stimuli. These results may however be misleading if the exact nature of the stimuli presented is not specified. A wider range of word stimuli which may have included word-types with which the patient has difficulty (affixed words for instance) is likely to have been presented to many patients; others may have been tested less thoroughly on aspects of word reading. Hence percentages given for different patients may not be directly comparable. An illustration of this variability is to be found in the two reports of RG presented in 1979. In the full case study presented by Beauvois and Dérouesné (1979) RG was presented with a range of stimuli, mainly nouns of varied lengths and syllabic composition on which his success rate ranged from 75 - 100%. On the short selection test which Dérouesné and Beauvois (1979) presented to patients who took part in their investigation of phonological processing RG (like the 3 other patients) scored 100%. Similarly structure and particularly length of nonwords may have a marked effect on performance. Temple and Marshall (1983) note that HM's performance on nonwords dropped from 60% when stimuli were simple CVC nonwords to zero when longer more complex nonsense words were presented. Normal subjects may not be 100% successful at performing certain tasks with nonword stimuli (Campbell and Butterworth, in press).

In demonstrating a dissociation between word and nonword reading performance it is therefore important to specify the materials used and to use words and nonwords which are a) of comparable length and complexity and b) of relatively short and simple structure so that normal readers might be expected to make no errors on the tests. The reading aloud of words and nonwords in this test and in the next test reported satisfies these requirements and scores on these tests provide the measure of dissociation of performance on word and nonword stimuli to which reference is made in discussion of individual cases. The possibility of an effect on performance resulting from the presentation of nonwords either intermixed with words or in nonword only lists has been considered (Patterson, 1982) but no effect of type of list was found for AM. In order to check that the dissociation between word and nonword reading ocurred in both types of list, this test was presented as a randomly intermixed list while the following test consists of homogeneous lists.

3.1.5.2 Reading aloud words and nonwords of different structure*

3.2.5.2.1 Introduction

This test is of particular importance in the present work and requires further explanation than tests discussed so far. The title of the test is shortened to "structured words/nonwords test" in the following discussion. Since the majority of phonological dyslexic patients with whom I worked not only obtained low success rates on nonword tests but also found such tests extremely arduous, it was clearly preferable to administer the minimum number compatible with gathering the data required. This test was therefore multi-purpose in design. Its primary purpose was to establish the precise locus of damage within the phonological route. Additionally, a subset of items in the test was matched for structure with real words in order to provide a further measure of the dissociation between word and nonword reading. Additional word lists were compiled as controls for the nonword lists (in which different structures were manipulated) in order to show that difficulty with particular structures occurred only in nonword reading and therefore implicated subsystems within the phonological route.

The subsystems which may be selectively impaired have been discussed in Chapter 2. They are:

i) the letter recognition system

ii) the resegmentation system

iii) the phoneme allocation system

iv) the blender

The early visual analysis system and response buffer are not considered as possible loci of impairment since they are common to lexical and phonological routes. It is assumed that nonword stimuli which increase the load on one subsystem while the load on other subsystems is held constant will be read less efficiently if that particular subsystem is malfunctioning/non-functional. Analysis of results of this test focusses on quantitative data although an analysis of errors is made. Observation of an appropriate error type (see later discussion of error analysis) would provide corroborative evidence of locus of impairment but it is assumed that absence of the predicted error type need not disconfirm the presence of damage at a given location since it may be the case that types of stimuli which require the action of an impaired processor may give rise to a variety of errors as a result of their utilising more of the available processing capacity.

3.1.5.2.2 The construction of nonword lists

Nonword stimuli are kept as short as possible (3-4 letters in length) in the hope of maximising performance on the test. Since pseudohomophony may affect performance pseudohomophones are avoided.

The variables which are manipulated in the stimuli are letter length, phoneme length, presence of a vowel digraph, presence of a consonant unit, presence of a silent e, and presence of a consonant cluster. There are 8 stimulus types, as shown in Table 3.1 and 20 items of each stimulus type. Performance on each list type may be compared with performance on any other list. List A items do not place a heavy load on any of the subsystems and performance on this set of items is taken as a baseline measure.

Table 3.1 Types of stimuli in the structured nonwords test

Type	Example[c]	Structure[a]	Number of Letters	Number of Phonemes	Presence of[b] Vowel digr.	Cons. unit	Silent e	Cons. cluster
A	tad	CVC	3	3	-	-	-	-
B	ank	VCC	3	3	-	-	-	+
C	ead	VVC or CVV	3	2	+	-	-	-
D	eth	VCC	3	2	-	+	-	-
E	tood	CVVC	4	3	+	-	-	-
F	dack	CCVC or CVCC	4	3	-	+	-	-
G	dunt	CCVC or CVCC	4	4	-	-	-	+
H	afe	VCe	3	2	-	-	+	-

Notes for Table 3.1

a C = Consonant
V = Vowel
= Indicates a digraph
e = silent e

b + = present
- = absent

c The inconsistent letters g and c are excluded from test items although the consonant unit ck occurs. The letter j is also excluded since some phoneticians regard it as a sequence of 2 phonemes (Ladefoged, 1975).

3.1.5.2.3 Predicted patterns of performance

The following predictions are made regarding the patterns of performance which would result from the impairment of each of the subsystems if that subsystem alone were impaired while the rest of the route functions without impairment.

3.1.5.2.3.1 Letter recognition system

The only variable which will affect performance is the number of letters in the stimulus. Performance on subtests containing 3-letter items (A, B, C, D and H) will be better than performance subtests caonting 4-letter items (E, F, G).

3.1.5.2.3.2 Resegmentation system

The only variable which will affect performance is the presence of a vowel digraph or consonant unit[1]. No predicition is made regarding the level of performance on Type H items since it is possible that a different type of resegmentation process is required for these stimuli and that this operation may be selectively impaired (see discussion in Chapter 1, Section 1.3.1.2.2.2). Scores on subtests containing items which require resegmentation (C, D, E, F) will be lower than scores on remaining subtests (A, B, G).

3.1.5.2.3.3 Phoneme allocation system

The presence of an inconsistent grapheme will affect performance if this subsystem is impaired. The proposed mode of operation of the Phoneme Allocation System is described in Chapter 1, Section 1.3.1.2.2.3. It is argued that an inconsistent grapheme will activate alternative phonemic realisations from which one phoneme must be selected. Thus an additional operation is required in the case of such graphemes. It is assumed, therefore, that in cases of impairment of the Phoneme Allocation System, stimuli containing an inconsistent grapheme which increase the load on the system, will be processed less efficiently than will stimuli which do not contain an inconsistent grapheme. The prediction is complicated in this case by the likelihood that the number of phonemes in the stimulus will also affect performance, since each additional phoneme will increase the load on the subsystem. The crucial scores are therefore those obtained on subtests which contain consonant units and those obtained on subtests which contain vowel digraphs. Items in subtests C and E are matched for letter and phoneme length with items in subtests D and F. Items in all 4 subtests (C, D, E, F) require resegmentation. The consonant units contained in items in Subtests D and F are not inconsistent[3], however, while the vowel digraphs contained in items in subtests C and E are inconsistent. Thus a pattern of results in which scores on subtests C and E are significantly lower than scores on subtests D and F indicates impairment of the Phoneme Allocation System.

Single inconsistent letters (g and c) are excluded from this test; inconsistent graphemes included are all vowel digraphs[2] for which Wijk (1966) lists alternative phonemic mappings.

3.1.5.2.3.4 The Blender

Again 2 variables will affect performance. These are the number of phonemes in the stimulus and the presence of a consonant cluster.
It is established that consonant clusters can be difficult to produce in speech. They are often simplified by children in the process of acquiring language (Clark and Clark, 1977) and may be difficult to produce in certain cases of acquired aphasia (e.g. Shankweiler and Harris, 1973). The question then arises of whether these clusters are more difficult to read, such difficulty being independent of speech production problems.

Snowling (1981) investigated the ability of a group of developmental dyslexics to read nonwords of different structure and found that their performance was adversely affected by the presence of a consonant cluster far more than the performance of normal readers. In a second experiment, Snowling considered the possibility that the reading deficit was part of a wider phonemic deficit which would be noticeable in speech as well as reading tasks. She found that there was no overall difference between the performance of normal and dyslexic readers in a repetition tast, and no difference in performance with nonword stimuli two or three syllables in length, or with word stimuli of any length, although dyslexic readers found four-syllable nonwords more difficult to repeat than did normal readers. Snowling concludes that "the possibility that their difficulty was a general articulatory-motor one seems unlikely since such a difficulty would surely have been reflected just as much in pronouncing the real words as the closely similar nonwords. It must be concluded that the dyslexic's difficulty arose with respect to the additional processing which had to be carried out for unfamiliar words."

This additional processing requirement did not affect the dyslexics' repetition of nonwords of less than four syllables, most of which contain consonant clusters. Errors in this task were, in any case, fewer than those which occurred in the reading task. By contrast, the presence of a consonant cluster affected reading performance when stimuli were of one or two syllables in length.

That the Blender is implicated in the increased difficulty shown by developmental dyslexics in reading nonwords containing consonant clusters follows from a process of elimination of the other systems involved in nonword reading. Phoneme-grapheme correspondence is one-to-one in the consonant cluster so that resegmentation is not required and the Resegmentation System, as described earlier, is not implicated. No alternative realisations are available for the consonants used in the present test (although a few of Snowling's stimuli did contain the inconsistent grapheme g). Thus the Phoneme Allocation System is not implicated in any effect of the presence of a consonant cluster in the present work and is unlikely to account for the full effect obtained by Snowling. Finally, as noted earlier, where there is no effect of the presence of a consonant cluster in repeating words and nonwords, then the difficulty is unlikely to be one of articulation.

The relative strength of influence of the two variables (phoneme length and presence of a consonant cluster) cannot be quantified from a theoretical standpoint. Type B and Type G items (containing consonant clusters) will be read less efficiently than Type A items. Type G items, which contain an additional phoneme may be read less efficiently than Type B items.

3.1.5.2.3.5 Multiple loci of impairment

In cases where there are no significant differences between scores corresponding to the patterns discussed in preceding sections, multiple loci of impairment are indicated. Possible combinations of impairment are discussed, where appropriate, in individual case reports.

3.1.5.2.4 Listing of structured nonword stimuli

Type A	Type B	Type C	Type D	Type E	Type F	Type G	Type H
tad	ank[4]	ead	eth	tood	duck	dunt	afe
dod	ipt	eap	ush	doad	fush	hant	obe
nud	alb	noo	uth	naud	shap	drap	ibe
lal	elt	oid	eck	lail	thut	bram	ine
mub	isp	aif	ath	maut	nath	dand	ane
yed	uld	voe	ith	yeed	huck	trab	eme
som	ont	oum	ish	soam	shum	trat	ove
mep	ind	oab	esh	meap	shen	yelt	ife
feb	esk	eem	osh	feep	thip	nold	ome
sab	emp	aum	ick	keak	poth	trin	ede
tib	ent	aup	oth	taud	fick	blap	ave
dup	elb	zie	uck	roid	dush	plet	ebe
nad	ump	oin	ack	deek	shan	blit	efe
hab	onk	ood	eth	paip	thup	rimp	epe
lup	ond	oom	ush	taum	dath	rond	ipe
tep	usp	eep	eck	keem	bick	yant	ite
rin	ilt	eaf	ath	yoam	shom	trib	ope
fid	int	oal	ith	peam	sheb	selt	ose
yab	und	oam	ish	feem	thad	neld	aze
sim	omp	auf	ick	leam	rith	tron	ike

3.1.5.2.5 **Word controls**

Lists of words which match the onwords in the first half of Lists A, E, F and G in structure were compiled. Each structural variation (letter length, presence of vowel digraph, presence of consonant unit, presence of consonant cluster) is represented in this subset of items. Only 10 words were included in each list so that comparison of word and nonword performance on lists of the same length could be made when a patient's nonword reading performance was so poor that only the first half of the structured nonwords test was administered. These words are shown below, the nonwords from the earlier lists with which they are matched are shown alongside them.

Type A

Words	Nonwords
bed	tad
lad	dod
tan	nud
pen	lal
cod	mub
dab	yed
rod	som
cab	mep
jet	feb
hit	sab

Type E

Words	Nonwords
food	tood
deed	doad
toad	naud
root	lail
bait	maut
peek	yeed
seal	soam
reap	meap
leak	feep
boil	keak

Type F

Words	Nonwords
pack	dack
hush	fush
sham	shap
thud	thut
path	nath[2]
luck	huck
shun	shum
shed	shen
thin	thip
moth	poth

Type G

Words	Nonwords
hunt	dunt
pant	hant
dram	drap
brat	bram
hand	dand
trap	trab
grab	trat
belt	yelt
gold	nold
grit	trin

Words in lists A and E and words in lists F and G are matched as closely as possible for frequency and performance on the two types of list is compared.

3.1.5.3 **Nonwords with inconsistent letters***

This test supplements the previous test with respect to inconsistent graphemes. The consonants c and g were used in nonwords in which they were followed by a vowel which indicated the correct phonemic realisation according to the rules formulated by Wijk (1966). Performance on 18 nonwords containing the letter c was compared with performance on a list of 18 nonwords of similar structure containing the consistent letters k (in 9 cases) and s (in 9 cases)in place of c. Similarly performance on the list of 18 nonwords containing g was compared with performance on a list in which *j* was substituted for *g*. Poor performance on the lists in which nonwords contained inconsistent graphemes which place more load on the phoneme allocation system, relative to performance on the lists in which nonwords do not contain inconsistent graphames, suggests impairment of the latter system.

c → /k/	cal	k → /k/	kal
	cax		kax
	candet		kandet
	coll		koll
	com		kom
	codden		kodden
	cuzz		kuzz
	cuck		kuck
	culden		kulden
c → /s/	cep	s → /s/	sep
	cemp		semp
	cendel		sendel
	cib		sib
	cint		sint
	cinten		sinten
	harcy		harsy
	cym		sym
	cylden		sylden
g → /g/	gat	j → /dʒ/	jat
	gan		jun
	galter		jutter
	goll		joll
	gom		jom
	gonden		jonden
	gub		jub
	gud		jud
	gusten		jasten
g → /dʒ/	gep	j → /dʒ/	jep
	gezz		jez
	gecken		jecken
	gid		jid
	gind		jind
	gisson		jisson
	hargy		harjy
	gye		jye
	gynten		jynten

3.1.5.4 **Nonwords synthesised from words** (Funnell, 1983)

This and the following 4 tests supplement the structured nonword tests with further investigation of the patient's ability to segment visually presented stimuli. The 10 nonwords are each made up of two adjacent real words. In order to produce a phonological representation for the nonword, the letter string must be segmented in order that the component words be recognised and the phonological representations of these words must then be blended. The test is in two forms. In the first, the nonwords are stencilled on card in a single colour. No comment on their composition was made to the patient. If the patient failed to read the nonwords and failed to recognize that they were composed of words (s)he was presented with the second form of the test in which the component words were visually distinguished by the use of different coloured ink. Failure on the second form of the test implicates the blender rather than the resegmentation system as the locus of impairment.

tugant
attype
fistam
topain
pother
hispat
hatein
biteto
pigham
nothat

3.1.5.5 **Segmentable words** (based on Funnell, 1983)

The test contains 30 words each of which comprises 2 further words. In 16 of the words the correct lexical prounciation of the segmented words does not correspond to the pronunciation of that segment in the parent word; in the remaining 14 words the pronunciation of each lexical segment corresponds to the pronunciation of the segment within the whole word. The test was administered in a visual and an aural form, the 2 forms being given in different sessions in order that responses should not be influenced by memory of the correct response in another modality. In the visual form of the test, the 2 types of stimuli were randomised and handwritten in lower case (non-cursive) on a sheet of paper. The patient was asked to draw a line at a position in the word so that the letters on either side of the line formed a real word. In the aural version the list of stimuli was read aloud and the patient asked to state verbally the 2 real words which comprised that word. This task could be performed through auditory processing on words in which the pronunciation of the lexical segment corresponds with the pronunciation of that segment within the parent word, but where the 2 pronunciations differ, knowledge of the orthographic form is required in order to produce a correct response. The inclusion of the latter type of word ensures that the task is not performed "by an auditory 'arm' of a model of phonological recoding, and not one that is necessarily involved in the assembly of phonology obtained from print" as Sartori et al (1984) suggest it may be in the case of Funnell's (1983) patient WB.

Words in which segmental pronuncations correspond	Words in which segmental pronunciations do not correspond
without	father
forget	door
inside	manage
rainbow	package
peanut	robbed
impact	heathen
inspire	panther

install
impair
peacock
raindrop
farmhouse
anyway
landlord

tenant
haddock
settee
onward
paddock
heron
herring
stirred
goat

3.1.5.6 **Hidden words** (based on Funnell, 1983)

Short (2-3 letter), high frequency words were concealed inside letter strings so that the resulting letter string formed a nonword. Hidden words were of different parts of speech, 8 being function words and 12 content words. Of the 12 content words, 6 were nouns, 4 adjectives and 2 verbs.

Letter strings were handwritten in lower case (non-cursive) on a sheet of paper. Funnell instructed her patient to find and read aloud the hidden words. The need to read the word aloud makes additional demands and might possibly, in the case of the deep dyslexic patient, have elicited semantic error responses. Patients were therefore told to underline the hidden word and were not required to read it aloud.

The type of segmentation operation involved in this task and the previous task differs from the type of resegmentation required to identify graphemes, since the part of the stimulus which must be segmented is invariably a whole word. Baron and Treiman (1980) note that it is easier for normal readers to segment letter strings into words or syllabic units than it is to segment them into phonemic units. The ability to perform the tasks shows that there is some capacity to break down the stimulus into parts but the resegmentation system within the phonological route is probably not involved in performing this operation - rather the ability may reflect the capacity of the visual word recognition system to operate against a background of noise. It is therefore to be expected that the ability to perform these tasks and the ability to segment a nonword stimulus into its component graphemes will dissociate.

adforsut
brifal
sedople
lamwol
thasry
hudogurt
altient
proilt
seduen
galowen
habigalt
stoot
adelont
sebuter
strunal
reseetel
recaral
degglod
poldesil
stapomed

3.1.5.7 **Sound Blending** (Kirk et al., 1968)

This test is a subtest of the Illinois Test of Psycholinguistic Abilities. It is included in the present test battery to provide an alternative means of assessing the operation of the blender. The patient is required to synthesise 24 words and 8 nonwords which are presented auditorially in separate segments (e.g."f-oot", /f-ʊt/); /); more difficult items are split into their component phonemes (e.g. "t-e-l-e-ph-o-n-e", / t-ɛ-l-ɪ-f-oʊ-n /. Segments are presented at half-second intervals. The patient is asked to synthesise the segments and pronounce the whole word/nonword. Kirk et al. suggest that the first 7 items of the test are presented with pictures to make the test suitable for use with young children. This was not felt to be necessary with adult patients and no picture cues were given.

1. f - oot
2. m - an
3. sh - oe
4. c - ap
5. c - ar
6. c - u - p
7. sh - i - p
8. ea - t
9. e - gg
10. u - p
11. c - ow
12. m - e
13. f - i - sh
14. c - a - t
15. b - i - g
16. s - a - d
17. b - oa - t
18. n - o - se
19. d - i - nn - er
20. f - ea - th - er
21. l - i - tt - le
22. k - e - tch - u - p
23. b - a b - ie - s
24. t - e - l - e - ph - o - n - e
25. /l-ɛ-k/
26. /eɪ-f-i/
27. /v - ʌ - m/
28. /r -æ - s - t/
29. /t - i - k - ꝏ/
30. /t - ɑ - p - ɪ - k/
31. /r - u - s - ꝏ - p/
32. /ꝏ - p - æ - s - t - o /

3.1.5.8 **Sound Blending II***

The majority of items in the previous test are real words. It is possible that, when subjects are adults who have acquired a normal vocabulary and stimuli are words, the task may be performed by lexical subsystems. In this case the task would be one of auditory word recognition under sub-optimal conditions. Nonword stimuli, by contrast cannot be treated in this way since they have no stored auditory or phonological representations. An additional test composed entirely of nonwords was used. Patients were presented with the component phonemes of the first five items of lists A to G from the structured nonwords test (35 items in all). Length of the items, which are reproduced below, ranges from 2 - 4 phonemes.

It should be noted that there are additional task demands in auditory sound blending tasks in which auditory perception and auditory short-term memory are involved. The existence of these additional demands means that poor performance on auditory sound blending tasks does not necessarily indicate impairment of the Blender.

<u>2 phonemes</u>

ea - d /i - d/
ea - p /i - p/
n - oo /n - u/
oi - d /ɔɪ- d/
ai - f /eɪ- f/
e - th /ɛ - θ/
u - sh /ʌ - ʃ/
u - th /ʌ - θ/
e - ck /ɛ - k/
a - th /æ - θ/

<u>3 phonemes</u>

t - a - d /t - æ - d/
d - o - d /d - ɒ - d/
n - u - d /n - ʌ - d/
l - a - l /l - æ - l/
m - u - b /m - ʌ - b/
a - n - k /æ - ŋ - k/
i - p - t /ɪ - p - t/
a - l - b /æ - l - b/
e - l - t /ɛ - l - t/
i - s - p /ɪ - s - p/
t - oo - d /t - u - d/
d - oa - d /d - oʊ- d
n - au - d /n- ɔ - d/
l - ai - l /l - eɪ - l/
m - au - t /m - ɔ - t/
d - a - ck /d - æ - k/
f - u - sh /f - ʌ - ʃ/
sh - a - p /ʃ- æ - p /
th - u - t /θ - ʌ - t/
n - a - th /n - æ - θ/

<u>4 phonemes</u>

d - u - n - t /d - ʌ - n - t/
h - a - n - t /h - æ - n - t/
d - r - a - p /d - r - æ - p/
b - r - a - m /b - r - æ - m/
d - a - n - d /d - æ - n - d/

3.1.5.9 **Consistent and Inconsistent nonwords***

The suggestion that nonwords are read by a process of lexical analogy rather than by grapheme-phoneme conversion at the level of the single grapheme has been discussed in Chapter 2. It was noted that Glushko (1979) had found that normal readers were significantly slower at reading nonwords containing an inconsistent segment than they were at reading consistent nonwords. If normal readers find inconsistent nonwords relatively difficult to process it is to be expected that readers who are impaired in their ability to assemble phonology will make more errors when stimuli are inconsistent nonwords. Failure to show an effect of consistency in such readers would present problems for the lexical analogy account of nonword reading, while the standard account would not predict such an effect.[6]

A list of 15 nonwords containing consistent final segments and a list of 15 nonwords containing inconsistent final segments matched for structure and letter length was prepared. Consistency was judged according to Glushko's (1979) implicit criteria and a number of the word pairs were taken from the lists provided by Glushko although further items were added to replace those omitted because they were pseudohomophonous or, in at least one case, real words. Note that this test is concerned with inconsistent <u>segments</u> while the structured word/nonword test (3.1.5.2) and the nonwords with inconsistent letters test (3.1.5.3) dealt with inconsistent <u>graphemes</u>.

Patients were asked to read the nonwords aloud.

<u>Consistent</u>	<u>Inconsistent</u>
aze	ave
bope	bove
brobe	brove
cath	coth
doop	doot
brean	breat

peam	peaf
ploom	plood
poom	pook
sust	sost
sweal	sweak
taze	tave
tring	trind
tife	tive
troat	troad

3.1.5.10 **Reading by analogy I: Deletion** (Bradley and Thomson, 1984)

This test was designed for use with a patient who was totally unable to read nonword stimuli other than by a process of altering a lexical phonological representation. This latter process was used spontaneously very infrequently but was used successfully far more often if an analogous word was provided with one letter ringed, the instruction to the patient being that he should say the sound of the word without the ringed letter. There are two types of analogous words. In Type A words removal of the phoneme corresponding to the ringed letter is the only manipulation necessary to produce a correct phonological representation; in Type B words the remaining phonemes need to be altered before pronunciation. The facilitatory effect on performance of the provision of an analogous word was not at the time interpreted as evidence of the use of a lexical analogy strategy for nonword reading but was accounted for in terms of a link between the output logogen system and the set of grapheme-phoneme correspondence rules in the phonological route, the hypothesised impairment being at the point at which the rule set must be accessed. This interpretation has recently been criticised (Barry and De Bastiani, in press) who propose that the results are better accounted for in terms of analogy strategy. However, the use of such a strategy would not account for the ability to read Type B nonwords, in fact the ability to substitute remaining phonemes is counter to the predictions of the lexical analogy model since it indicates processing at the phonemic rather than the lexical level. In spite of this difficulty in interpreting certain patterns of results on this test, it was felt to be useful to include it in the test battery. The pattern which would be most compatible with lexical analogy models would be that in which Type A items were read more successfully than Type B items.

Test procedure was the same as that used in the original administration of the test. Patients were first asked to read a list of the stimulus words, typed lower case on paper without ringed letters to ensure that all words could be read. Any words not read were omitted from the test set. Patients were then presented with 3 trial words and instructed to say the word without the ringed letter. Help was given with trial words if required to ensure that the task was understood. Test words were then presented singly in random order.

Stimulus	Correct nonword response	
Type A items		
drink	dink	/dɪnk/
doctor[a]	octor	/ɒktə/
take	ake	/eɪk/
dress	dess	/dɛs/
boy	oy	/ɔɪ/
bird	bir	/bɜ/
hand	han	/hæn/
spring	spring	/spɪŋ/
street	steet	/stit/
bed	ed	/ɛd/
star	sar	/sɑ/
home	ome	/oʊm/

train	tain	/teɪn/
bag	ag	/æg/
milk	mik	/mɪk/

Type B items

box	bo	/boʊ/
earth	arth	/ɑθ/
fall	fal	/fæl/
foot	fot	/fɒt/
door	doo	/du/
farm	fam	/fæm/
book	bok	/bɒk/
wound[b]	wond	wɒnd/
or		
salt	sal	/sæl/
child	chid	/tʃɪd/
branch	branc	/brænk/
chair	cair	/kɛə/
woman	woan	/woʊn/
girl	gil	/gɪl/
river	rive	/rɑɪv/
class	cass	/kæ s/
uncle	unce	/ʌns/
bowl	bol	/bɒl/
family	faily	/feɪli/
moon	mon	/mɒn/

Ringed letters are underlined in the preceding list.

Notes

a) There are 2 alternative pronunciations for the nonword formed from this word, one of which involves a change in remaining phonemes (/ɒktɔ /) and one which does not (/ɒktə /). The item was therefore classified as a Type B item if the former pronunciation was produced.

b) There are 2 alternative pronunciations for the original word here, but whichever pronunciation is chosen a change of vowel sound must be made to pronounce the nonword.

c) The stimulus word may be pronounced /klæs/ or /klɑs/ according to accent. If a patient roduced the former pronuncation the stem was reclassified as a Type A item.

3.1.5.11 Reading by analogy II: Substitution*

The items in this test are similar to those in the previous test in that they contain a ringed letter. However they differ in that a letter is printed above the ringed letter and the instruction is to substitute this letter for the ringed letter. The substitution operation always results in the formation of a nonword and is the only manipulation required in this test, no further manipulation of the remaining phonemes is necessary. The possibility of an effect of the phonetic relationship between ringed and substitute phoneme is examined in this test. The 14 original words are each presented twice, once with a substitute letter which differs in voice only from the ringed letter and once with a substitute which differs in place, manner and voice.

As with the previous test, the list of base words without ringed letters was first presented for reading aloud and failed words were omitted from the test set. The task was explained using demonstration items.

The stimuli are listed giving the nonwords which result from letter substitution. The format of the stimuli when presented individually to the patients is shown in the following examples:

p	z	p	f
bag;	bag;	boy;	boy

Base word	Substitute differs in voice only	Substitute differs in place, manner or voice
bag	pag	zag
bed	ped	zed
bid	pid	fid
boy	poy	foy
fill	vill	lill
food	vood	pood
king	ging	jing
past	bast	nast
peal	beal	jeal
pick	bick	jick
pine	bine	rine
plan	blan	vlan
take	dake	vake
zoo	soo	joo

3.1.5.12 **Pseudohomophy** I (Coltheart, 1981b)

This test contains 30 3-letter nonwords, 15 of which are pseudohomophones and 15 of which are not. The patient is asked to read aloud each item.

Pseudohomophones	Non-pseudohomophones
wun	bon
uze	mun
woz	gue
owt	oin
wor	foo
bie	kie
hoo	hoz
fue	ekt
oan	bue
akt	kag
doo	sem
nue	ont
kan	noo
sed	ine
ize	ume

3.1.5.13 **Pseudohomophony** II*

This is a more difficult version of the previous test in which items are all more than 3 letters in length. The possible overlap between homophony and visual similarity to a word has been investigated by Martin (1982) who concluded that visual similarity was the more important variable. Dérouesné and Beauvois (1985) have shown, on the other hand, that the pseudohomophony effect can remain even when the pseudohomophone is visually distinct from a real word. Visual similarity is controlled in this test by ensuring that non-homophonous items contained as many letters of the real word as do the pseudohomophones. The test contains 10 pseudohomophones and 10 non-pseudohomophones of similar length and structure.

Pseudohomophones	Homophonic Real Words	Non-pseudohomophones
leiter	later	louter
phool	fool	shool
kreme	cream	krame
madjik	magic	madlik
kaje	cage	kade
larfter	laughter	larnter
inuff	enough	inull
ligh	lie	lish
lepperd	leopard	lepwerd
biskit	biscuit	bislit

3.1.5.14 **Reading aloud difficult lexical decision** (Coltheart, 1981b)

The majority of nonword tests described so far have deliberately used short stimuli with the aim of eliciting as many reponses as possible. Many of the patients with whom I worked would not even attempt to pronounce a multisyllabic nonword. Furthermore, the tests require comparison of proportions of correct responses and where multisyllabic nonword stimuli are concerned, success rate may fall to zero (e.g. Temple and Marshall, 1983) even when some response is produced. Patients were initially asked to read 6 of these stimuli. If they made no response to any of these 6 items, the full test was not administered. If they attempted at least 2 items and were willing to continue, the full set of words and nonwords (listed in Section 3.1.2.2.2) was presented.

3.1.5.15 Silents test of phonology I (Coltheart, 1981b)

These tests are presented in order to identify cases in which the major impairment is in the articulation of nonwords rather than in the ability to assemble phonology. Pairs of nonwords controlled for visual similarity, are presented to the patient who must decide whether or not the pair is homophonic. Patients were asked to assign each card on which a pair of nonwords was stencilled to a "same" (homophonic) or "different" (non-homophonic) pile. In addition to the nonword version of the test, the versions using regularly and irregularly spelled words (originally designed for investigation of surface dyslexia) were given so that a comparison of performance on word and nonword tests could be made. The tests clearly make demands on short-term memory since the phonology for the first item of the pair must be stored in memory which phonology for the second item is obtained and the two pronunciations then compared. Failure on the nonword version alone could be due to inability to assemble phonlogy or to a short term memory deficit. The latter problem would be reflected by poor performance on word as well as nonword versions. If failure is entirely due to inability to assemble phonology, performance on the nonword version should be impaired relative to performance on the word versions. No difference in performance on "regular" and "irregular" versions would be expected in cases of phonological and deep dyslexia.

3.1.5.15.1 **Nonword Version**

Homophonic pairs		Non-homphonic pairs	
afe	aif	afe	auf
fid	phid	fid	prid
gede	jead	gede	teld
cobe	koab	cobe	roib
quead	kweed	querd	smeed
feks	phex	feps	brex
rabe	raib	rabe	ralb
zole	zoal	zolk	zoul
aud	awd	ald	ard
coim	koym	colm	boym
voze	voes	vone	voer
eaf	eeph	erf	eeps
cade	kaid	cade	rald
keam	keem	kerm	keem
hyle	hile	hule	hile
nane	nain	nank	nain
nime	nyme	nime	nume
bew	bue	bem	bue
fyde	phide	fyde	prode
caum	kawm	caum	raim
scane	skain	scang	skain
ko	koe	ko	kor
foun	fown	foon	fown
bauze	baws	bauze	bams
voard	vored	vound	voned

3.1.5.15.2 **Regular word version**

Homophonic pairs		Non-homophonic pairs	
blew	blue	bled	blue
clause	claws	clause	clams
days	daze	days	dare
hair	hare	hair	hard
higher	hire	higher	hive
hole	whole	here	where
hymn	him	home	him
lacks	lax	laces	lax
loan	lone	loan	long
paced	paste	paged	paste
pain	pane	pain	pant
plain	plane	plain	plant
praise	prays	praise	prams
raise	rays	raise	rats
sail	sale	sail	salt

side	sighed	side	signed
sighs	size	signs	size
soar	sore	sour	sore
tacks	tax	talks	tax
tail	tale	tail	talk
way	weigh	was	weigh
which	witch	which	winch
pause	paws	pause	pads
made	maid	wade	ward
board	bored	bound	boned

3.1.5.15.3 **Irregular word version**

Homophonic pairs		Non-homophonic pairs	
ail	ale	air	are
bare	bear	dare	dear
berry	bury	ferry	fury
bold	bowled	bold	boiled
brake	break	snake	sneak
build	billed	built	billet
doe	dough	roe	rough
earn	urn	barn	urn
eye	I	eve	I
hear	here	wear	were
know	no	knob	no
knows	nose	knots	nose
mare	mayor	mare	major
moan	mown	moan	moon
mode	mowed	mode	moved
none	nun	bone	bun
pair	pear	fair	fear
seas	seize	sets	seize
sew	so	new	no
sole	soul	sole	soil
some	sum	home	hum
stake	steak	stale	steal
thrown	throne	thrown	throng
key	quay	cry	quay
peace	piece	pence	piece

3.1.5.16 **Silent test of phonology II***

This test, like the previous one does not require articulation. It was designed to reduce the involvement of short-term memory which is required in the previous tests and also in the alternative test suggested by Coltheart in which the patient is asked to judge whether or not a nonword sounds like a word. In the latter case, the assembled phonological representation must be held in short term memory while the oral word representation system is searched for a match. The present test requires the patient to judge whether or not a nonword is pronounceable and to indicate his choice by marking each item with a tick or a cross. Since unpronounceable words are also orthographically illegal[7] (see Henderson, 1982, Chapter 4 for discussion of pronounceability) all 40 items in the test are orthographically illegal (that is they contain sequences of letters in position in which they are never observed in English words) so that the criteria of orthographic legality and word-likeness cannot be used in making judgements. All words contain a vowel so that judgement cannot be based on the knowledge that the absence of a vowel renders a letter string unpronounceable. Half of the items presented are pronounceable, half are not. The items are randomly intermixed and stencilled on a sheet of paper. No time limit was set for the test.

Pronounceable nonwords	Unpronounceable nonwords
trau	rtan
akkan	alkcn
prakk	ktarn
rovv	rvon
entov	ntove
vui	vce
griu	rgue
pagiv	saipg
fikken	fickcn
aspuo	dspee
ckalt	tkald
pui	dpe
ckise	spdce
droj	rdoe
bewh	hbew
voyyen	voydtn
salq	ndal
chlav	clhar
farq	fque
hidj	jdap

3.1.5.17 **Inappropriately suffixed nonwords***

This test relates to the issue of whether or not the visual recognition system is morpheme-based. Nonwords formed from a real-word root morpheme linked with a suffix which that word never takes may be no easier for the patients who cannot assemble phonology to read aloud than any other nonword (WB, Funnell, 1983) or may be read more efficiently than nonwords which are not affixed (Leonardo, Job and Sartori, 1984). The test contains 25 such nonwords presented individually for reading aloud.

firster
problemer
dogest
gardenest
husbandest
mouthest
darking
freshing
daying
thinging
colded
sweeted
brighted
deeped
coatly
helply
bringly
happenly
followly
beatly
speakest
explainest
supportest
enjoyest
wantest

3.1.5.18 **Affixes in isolation***

This test, like the previous one, is concerned with the issue of morphological decomposition. Different accounts of the decomposition process make different predictions about the ability to read affixes in isolation. If morphological decomposition does not occur at the visual word recognition stage, affixes should not be read in isolation. If affixes are processed via the phonological route, they should be difficult to read in isolation as well as when they are legally attached to words. If, as Job and Sartori (1984) suggest, there are separate visual recognition devices for root morphemes and affixes, then it is possible that affixes in isolation will be read as efficiently as real words and far better than nonwords. Ten affixes (eight suffixes, 1 prefix and 1 prefix or suffix) which do not form real words when standing alone were presented individually for reading aloud.

ly
ably
ed
ing
ment
un
ness
er
ous
en

3.1.6 Tests of repetition ability

Repetition ability is investigated to some extent in the BDAE but additional tests focussing on the repetition of nonwords are required in order to identify cases in which the impairment of nonword reading is due to difficulty in articulating unfamiliar segments rather than to difficulty in assembling phonology. Selected tests and subtests from previous sections were therefore presented orally for repetition. These were:

3.1.6.1 **Pseudohomophony** I (Coltheart, 1981b) (Section 3.1.5.12)

The test, when presented orally contains 15 words (since half the nonwords in the test are pseudohomophones) and 15 nonwords. A comparison of performance on word and nonword stimuli can therefore be made.

3.1.6.2 **Easy Lexical Decision** (Coltheart, 1981b) (Section 3.1.2.2.1)

Contains 25 words and 25 nonwords which were presented orally for repetition. Again the presence of words and nonwords in the test allows a comparison of performance on the two types of stimuli to be made.

3.1.6.3 **Nonwords of different structure*** (Section 3.1.5.2.4)

The first 10 nonwords in lists A - G were presented orally for repetition. If different types of nonword are more difficult to articulate, this task will reveal the difficulty. If, however, repetition performance is constant across the different lists, it can be concluded that differences in reading performance are in no way due to articulatory difficulty.

3.1.7 Composite list of tests administered and their sources

Neuropsychological background tests.

Boston Diagnostic Aphasia Examination (Goodglass and Kaplan, 1983; 1972)
Boston Naming Test (Kaplan et al. (1983)
Wechsler Memory Scale (Wechsler and Stone, 1948)

Token Test (shortened version) (De Renzi and Faglioni, 1978)
Peabody Picture Vocabulary Test (spoken and written version) (Dunn, 1965)

Reading aloud

Single letter level.

Single letter naming
Single letter sounding
Single letters from a string*
Cross-case letter matching (Coltheart, 1981b)

Single word level

Easy lexical decision (Coltheart, 1981b)
Difficult lexical decision (Coltheart, 1981b)
Imageability (standard) (adapted from Coltheart, 1981b)
Imageability (difficult)*
Part of speech (easy) (Warrington, 1981)
Part of speech (difficult)*
Part of speech (revised)*
Regularity of spelling (standard) (Coltheart, 1981b).
Regularity of spelling (difficult)*
Frequency*
Word length*
Presence of suffix I*
Presence of suffix II*

Reading Text.

Comprehension tests

Synonym matching (Coltheart, 1981b)
Semantic probe (Funnell, 1983)
Comprehension of functors (based on Morton and Patterson, 1980b).

Morphological knowledge

Test of morphological knowledge.

Nonword processing

Reading aloud Easy Lexical Decision (Coltheart, 1981b)
Reading aloud words and nonwords of different structure*
Nonwords with inconsistent letters*
Nonwords synthesised from words (Funnell, 1983)
Segmentable words (based on Funnell, 1983)
Hidden words (based on Funnell, 1983)
Sound Blending I (Kirk et al., 1968)
Sound Blending II*
Consistent and inconsistent nonwords*
Reading by analogy I: Deletion (Bradley and Thomson, 1984)

Reading by analogy II: Substitution*
Pseudohomophony I (Coltheart, 1981b)
Pseudohomophy II*
Reading aloud Difficult Lexical Decision (Coltheart, 1981b)
Silent tests of phonology I (Coltheart, 1981b)
Silent test of phonology II*
Inappropriately suffixed nonwords*
Affixes in isolation*

Repetition ability

Pseudohomophony I (Coltheart, 1981b)
Easy lexical decision (Coltheart, 1981b)
Nonwords of different structure*

* indicates a new test, devised in the course of this research.

3.2. Statistical Analysis

Tests of statistical significance have been used where appropriate in analysing the test results of individual patients. The use of the case study methodology in investigating the reading behaviour of a heterogeneous group makes the wide use of statistical testing in between-subjects comparisons inexpedient.

In the majority of tests, one or more variables are manipulated so that the test contains two or more lists of items, the scores on each list requiring comparison. In such cases a chi-squared (X^2) analysis is performed on the results. The chi-squared value obtained may be inaccurate if any of the expected values are less than 5 (Meddis, 1975). Where low expected values would occur in 2 x 2 chi-squared analyses, Fisher's (2 x 2) exact test is used instead. Since totals frequently exceed 26, it is necessary to compute Z when using this test (Meddis, 1975). Fisher's test cannot, however, be used when more than 2 categories require comparison. The inaccuracy resulting from low expected values always increases the value of X^2. Therefore if the X^2 value obtained where expected values are low does not reach significance, there is no reason to query the "not significant" statement. If, however, the X^2 value only just reaches significance and expected values are low, there is reason to doubt whether the X^2 value truly indicates a significant effect of a variable. Possible inaccuracy is recorded in the case reports by the use of the symbol * against the chi-squared value in question. The closer the expected value comes to 5, the less likely it is that the X^2 value is inaccurate. Where expected values are very low (<1) the analysis is not performed.

In the Word Length tests which yield a series of values, the S value from Kendall's test for rankable scores is calculated (Meddis, 1975). Certain tests (e.g. lexical decision tests) require Yes/No judgements to be made and do not yield 2 or more scores for comparison. In such cases the measure of sensitivity d prime (d') is calculated (see Davies and Parasuraman, 1982, Chapter 3 for discussion of this statistic). Values of d' are obtained from the tables prepared by Freeman (1973).

The major use which is made of between-subjects data is in establishing the extent to which scores relating to 2 different aspects of a patients' performance correlate. For this purpose the measure of correlation used is Kendall's S. A rank order correlation is preferable in these analyses since percentages rather than raw scores are used.

3.3 Error classification systems

3.3.1 Classification of reading error responses to words

The use of certain error categories in the analysis of the word-reading errors of acquired reading disordered patients has become conventional in the studies which have followed the seminal papers of Marshall and Newcombe (1966, 1973). Visual similarity or semantic relatedness of target and response have, as might be expected, been noted in much earlier reports (e.g. Low, 1931). The following error categories may be regarded as standard in studies of acquired dyslexia: visual, derivational and inflectional, semantic, function word substitution.

3.3.1.1 **Visual errors**

The criteria by which errors are classified as visual are those stated by Morton and Patterson (1980a):

i) 50% of the letters in the response word must be present in the stimulus word, and

ii) there must be "some semblance of correct order" where these letters are concerned.

Morton and Patterson note that (ii) depends on subjective judgement. With regard to this latter requirement a degree of leniency characterises the classification of an error as visual; the first requirement is always met, however.

Because of the theoretical relevance of the nature of visual errors to the issue of the validity of lexical pooling models which postulate the activation of a word's orthographic neighbours on presentation of a visual stimulus, this error category is subdivided according to whether shared letters are in initial, medial or final positions.

3.3.1.2 Morphological (derivational and inflectional) errors

Sartori et al. (1984) note that "as yet no reports have analysed possible differences between 'inflectional' and 'derivational' errors in English. The two types of error are assigned to different categories in the error corpora provided in this work. Inflectional errors are those in which target and response are of the same part of speech (excluding certain derived noun forms such as piano/pianist), the inflection signalling differences in number, person, tense or adjectival form. The nature of the difference is noted within the "inflectional error" category. The regularity or irregularity of nominal plural formations and of verbal past formations is also noted; irregular formations may occasionally be visually distant from their present tense forms (e.g. go/went). The occurrence of irregular formations which are not in affixed form (e.g. run/ran) is of relevance to the issue discussed in Chapter 2 of the conceptualisation of the process of affix stripping.

Derivational errors are those in which target and response differ in part of speech. Error responses in which target or response end in -ing which may signal verbal tense or gerundial form may be inflectional or derivational and are therefore assigned to a separate category.

3.3.1.3 Semantic errors

These errors in which target and response are semantically related are subdivided according to a scheme suggested by Coltheart (1980d) into associative and shared feature errors, the latter being further subdivided into superordinate, subordinate and coordinate errors. The two main subdivisions may (as Shallice and Warrington (1980) tentatively suggest) distinguish 2 different varieties of deep dyslexia in which semantic errors are produced by impairment in a different location. A predominance of shared feature errors would be expected in "input" deep dyslexics who have difficulty in accessing a semantic representation. "Output" deep dyslexics who are able to obtain a semantic code but have difficulty in obtaining an oral word representation by means of this semantic code (see discussion by Barry and Richardson, 1982) might be expected to make associative errors.

3.3.1.4 Function word substitutions

These are errors in which target and response are both function words. The error response may be visually similar (e.g. there -> "here" or visually dissimilar (e.g. and -> "but" to the target. This error type is subdivided according to visual similarity.

3.3.1.5 Problems in error classification

Patterson (1980b) notes in discussing the reading error corpora for PW and DE, many errors do not fall clearly into one or other category. Derivational and inflectional errors are always semantically and usually visually related to their targets. Function word substitutions are semantically related to their targets at least as far as form class is concerned and are sometimes more closely semantically related. There is thus a certain amount of flexibility in classifying errors - hence the desirability of providing error corpora in all studies of acquired dyslexic patients. The pattern of errors as a whole may yield "clues" as to correct classification. For instance, if no semantic errors are recorded other than those in which stimulus and response are derivationally related it seems unlikely that these errors are in fact a sub-class of semantic error. Similarly, if no or very few semantic but many visual errors are recorded, it seems more likely that an error response which is semantically and visually related to the target has occurred because of visual rather than semantic confusion. A separate error category has been provided for errors that may be visual or semantic however, since these may occur in the corpora of patients who make both visual and semantic errors. A further category is provided for errors which appear to result from visual and semantic confusion (e.g. <u>county</u> $\rightarrow$ (country?) $\rightarrow$ "houses").

3.3.1.6 Other error categories

A variety of errors which do not fit into the system so far described may occur. Such errors have been classified as far as possible to avoid large proportions of errors being assigned to a general "other" category. Such a category is unhelpful in the precise description of patterns of impairment. Some categories which have been observed to recur are:

3.3.1.6.1 **Completion errors** (e.g. <u>under</u> → "underpass")

Marshall and Newcombe (1966) label this type of error "visual completion errors". However they could arise at the output stage as a result of failure to suppress articulatory codes which frequently occur in association with the articulatory code of the target. Completion errors in which a phrase rather than a longer word is produced in response to a single word (e.g. <u>excuse</u> → "excuse me") could only be produced in this way, since, in current models, the visual recognition system does not contain supra-word units.

3.3.1.6.2 **Phonemic paraphasias** (e.g. <u>pant</u> →/ pæŋk /)

These involve the substitution of 1 or more phonemes of the correct response such that the resultant pronunciation is still recognisably close to the target. The source of such errors could, of course, be visual but, in patients who are reading via lexical routes, visual errors only produce responses which are words. An error is only assigned to this category if it is a nonword unless further investigation of the error (usually requesting definition) has been undertaken. The error occurs during articulation of the stimulus and similar errors might be expected to occur in spontaneous speech.

3.3.1.6.3 Perseverations

The mechanism responsible for such errors has not been clarified. It may be that failure to obtain a response for a variety of reasons leads to production of a past response "lingering" in the response buffer. Alternatively, failure to delete this response after articulation may lead to its over-riding the correct response. The latter account is formulated somewhat differently by Albert et al. (1981) who explain perseverative errors in terms of a generalised inability to adapt to changing task demands.

3.3.1.6.4 **Regularisations** (e.g. <u>bury</u> → /bʌri /)

These errors are indicative of reliance on the phonological route and characterise the reading of surface dyslexic patients. They may occur very occasionally in the reading of patients relying on lexical routes, presumably indicating occasional and intermittent use of the phonological route. Why this should occur is unclear; such errors are however not incomprehensible when some nonword reading ability is retained.

3.3.1.6.5 **Attempts to read via a process of grapheme-phoneme conversion**

An error type related to the previous category is that which reflects unsuccessful attempts to read via a process of grapheme-phoneme coversion (g-p-c errors) although the results are not regularisations (e.g. yacht -> /jæt /).

3.3.1.6.6 **Blending** (e.g. insipid -> /ɪn-sɪp-ɪd /)

Such errors tend to occur when reading compound words, the component words being pronounced separately rather than synthesised into a blended whole. Such errors can also occur on longer words which appear to be syllabified at some stage in the reading process.

3.3.1.6.7 **Possibly visual** (e.g. lad -> "leg"; average -> "engine"

These errors appear to bear some visual resemblance to the stimuli but do not satisfy the strict criteria laid down for visual errors. They are fairly frequent in some patients and, if they are indeed visual in origin may result in a misleadingly low proportion of visual errors being recorded.

3.3.1.6.8 **Bizarre** (e.g. connoisseur ->/ɪn'skrɒpəl/)

This category is reserved for errors which appear totally unrelated to the target. Word or nonword error responses may be assigned to this category.

3.3.1.6.9 **Substitution, addition, or omission of word segments**

This category is discussed fully in Case Report VII, Section 4.9.7.5.

3.3.1.7 Summary of classification of reading error responses to words

Main error category	Subdivision of category
Visual	sharing initial letter(s) with stimulus
	sharing initial and final letter(s) with stimulus
	sharing final letter(s) with stimulus
	sharing medial letter(s) with stimulus
	sharing letters not in corresponding positions
Visual or semantic	
Visual then semantic	
Derivational	
Derivational or inflectional (-ing)	
Inflectional	Nouns
	Verbs
	Adjectives
Function word substitutions	Visually similar
	Visually dissimilar
Semantic	Associative
	Shared feature - superordinate
	subordinate
	coordinate
Other e.g.	Completion
	Phonemic paraphasias
	Perseveration
	Regularisation
	Attempt to read via process of grapheme-phoneme conversion
	Blending
	Possibly visual
	Substitution, addition, or omission of word segments
	Bizarre

3.3.2 The problem of multiple responses

It is not uncommon for 2 or 3 (or even more) attempts to be made to read a word. These attempts are interesting in that they reveal knowledge of error. They are also difficult to classify. In order that no errors remain unclassified and in preference to the provision of a "multiple response" category, each separate response of a multiple error response has been assigned to the appropriate category. This procedure is applied to initial error responses which are subsequently corrected. Such responses are marked C in the error corpora. The separate classification of multiple error responses has the effect of augmenting the error corpus to some extent.

3.3.3 Omissions

Omissions are recorded in a separate section within the error corpora.

3.3.4 Error totals

The number of errors in each error category is expressed as a percentage of the total errors recorded. Omissions are not included within the error total. Due to the separate classfication of multiple error responses the total number of errors does not equal the total number of words misread. The latter total is separately recorded and expressed as a proportion of the words presented as are the total number of omissions and the total number of words read correctly.

3.4 Classification of reading error responses to nonwords

Error responses on nonwords are usually classified on the basis of whether or not they are words (e.g. Sartori et al., 1984). The significance of this distinction relates to the route which has produced the error. Lexicalisations it is argued (see Section 4.1), are produced by the inappropriate use of a lexical route and in themselves are not informative about the processes involved in reading via the phonological route (although analysis of the types of nonword on which they are most likely to occur is revealing).

3.4.1 Lexicalisations

Lexicalisations may be visually similar to the stimulus. If they are, a subdivision of the error category according to the position of shared letters is appropriate. As with error responses to words, this relationship between stimulus and response relates to the issue of the activation of orthographic neighbours. Lexicalisations which are visually distinct from the stimulus, in that they do not satisfy the criteria for visual error classification, occasionally occur. Such responses usually bear some visual resemblance to the target however. If lexicalisations are visually dissimilar from the stimulus, they may, as Dérouesné and Beauvois (1985) note, result from the use of the phonological rather than the lexical route, especially if they do bear a strong phonological relationship to the target. Unfortunately since visual and phonological similarity usually co-vary, it is usually extremely difficult to determine the extent of visual versus phonological similarity. Position of shared letters is noted as for visually similar lexicalisations with the additional subdivision "no letters". If phonological similarity is the important factor, then the fact that the response is a word may be purely fortuitous or may result from a strategy of approximate phonological access to the output word representation system.

3.4.2 Incorrect nonwords

The relationship between the stimulus and response in this type of error varies considerably between patients. Error types which have been observed to occur in the performance of more than one patient are gross or multiple errors of grapheme-phoneme conversion (e.g. peam -> /pɒn / in which the response is only remotely phonologically related to the target and at least 2 distinct errors can be identified, phonemic realisation of silent e (e.g. efe -> /ɛfi / and errors involving a single grapheme/phoneme (e.g. gub -> /gʌp /). The latter category is subdivided according to whether a single grapheme/phoneme has been substituted, added, or omitted in the response.

Reponses which fit into neither of the main categories described above are rare. Nonword errors which fall into the Other category and which are observed to occur in the corpora of more than patient are Blending errors in which an unblended string of phonemes (correct or incorrect) is produced and Literation errors in which the patient simply names (correctly or incorrectly) the component letters of the nonword.

3.4.3 Summary of classification of reading error responses to nonwords

Main error category	Subdivision of category
Lexicalisation	Visually similar to stimulus - sharing initial letter(s) with stimulus - sharing initial and final letter(s) with stimulus - sharing final letter(s) with stimulus - sharing medial letter(s) with stimulus - sharing letters not in corresponding positions
	Visually distinct from stimulus - sharing initial letter(s) with stimulus - sharing initial and final letter(s) with stimulus - sharing final letter(s) with stimulus - sharing medial letter(s) with stimulus - sharing letters not in corresponding positions - sharing no letters with stimulus - sharing phoneme(s) but not letters with stimulus

Incorrect words	Gross/multiple errors of grapheme-phoneme conversion Substitution of a single grapheme/phoneme Addition of a single grapheme/phoneme Omission of a single grapheme/phoneme Phonemic realisation of silent e
Other	Blending Literation

3.4.4 **Multiple responses and error totals**

The procedure used for dealing with multiple error responses is the same as that described in the section on the classification of errors on words. Number of errors in each category is expressed as a percentage of total errors recorded. The number of omissions, the number of nonwords misread and the number of nonwords read correctly are expressed as percentages of the total number of words presented.

NOTES FOR CHAPTER 3

1 I note the suggestion made by Marshall (personal communication) that resegmentation errors of commission rather than of omission may be made, i.e. that letter strings in which letter sound correspondences are one-to-one are gratuitously segmented into "pseudographemes" which cannot find a phoneme match. In this case errors would presumably not occur more on any one type of letter string than on any other. Since there is already evidence that letter strings containing digraphs are particularly difficult for some phonological dyslexics (Dérouesné and Beauvois, 1979) it is assumed that impairment of the system tends to result in failure to segment where this is required rather than inappropriate segmentation of strings which do not require segmentation. This must, of course, be the effect of total non-functioning of the resegmentation subsystem.

2 Inconsistency of graphemes rather than of larger units is controlled in this test. If List E nonwords are segmented according to Glushko's (1979) method, the majority are consistent, only 3/20 being clearly inconsistent.

3 Because only 2 consonant units (sh and ck) are totally consistent, the unit th is included in the stimuli. This unit differs from others in that its two possible phonemic realisations differ only in voicing. It was not possible to compile a set of 29 different non-psuedohomophonic nonwords without using an additional unit -

in fact even when this unit was used, it was necessary to repeat some of the stimuli in List D. Any effect of the possible inconsistency of th would reduce rather than produce differences between the sets and makes the test slightly less sensitive.

Where stimuli were repeated, the same nonword was never presented twice in the same session. The test was in any case administered over 2-3 sessions because of its length.

4 Karalyn Patterson has pointed out that consonant clusters which consist of consecutive plosive consonants are phonotactically complex and that this factor could contribute to an effect of this variable. Only 1 out of the 40 stimuli falls into this category (ipt) so that the effect of this factor would be minimal. Additionally, repetition performance on the same stimuli is checked and a significant difference in performance on Type B and Type G nonwords in the repetition task would be noted in interpreting the results of the reading test.

5 Word lists in which different aspects of work structure are varied were included in an early version of this test. Comparisons of performance on the following word subtests are not carried out but items are listed below since responses to items in these subtests (where administered) are included in the error corpora).

Subtest X: Presence of silent e

Words containing silent e	Words not containing silent e
rake	mat
hive	hip
lane	tap
tape	pal
haze	tab
hate	log
lake	lip
safe	big
wane	sag
nice	fat

Subtest Y: Vowel digraphs and consecutive vowels

Words containing a vowel digraph	Words containing consecutive vowels
sleep	cruel
moat	duel
peat	suet
load	poem
loam	noel
weapon	museum
audit	oasis
snail	fluid
seed	ruin
weal	duet

Subtest Z: Silent letters and consonant clusters

Words containing a silent letter	Words containing a consonant cluster
bomb	pint
comb	grin
debt	lamp
lamb	fund
folk	desk
calf	tint
knot	rent
hymn	wink
damn	sped
writ	cask

6 Dérousné and Beauvois (1985) have presented evidence from phonological dyslexia which, they argue, supports lexical analogy theory. They presented lists of nonwords made up of sub-syllabic units which do or do not occur in French written words to the phonological dyslexic LB for reading aloud. Although Derouesne and Beauvois claim that the two types of nonword used do not differ in pronounceability this claim is open to question. The consonant clusters which they use "appear quite frequently in spontaneous speech". However, pronounceability of a syllable in the flow of normal speech and its pronounceability in isolation may differ. Note that there are consonant clusters in English which are phonotactically acceptable in word final positions (e.g. nt) but unpronounceable in word initial positions or in isolation. Dérouesné and Beauvois' syllables which do not appear in French words are extremely difficult for me, as a not-very-fluent French speaker, to pronounce. I also presented both lists of stimuli to a native speaker of French working as a secretary in the University. She was simply asked to read aloud the nonsense syllables without comment on there being different types. The list of consonant clusters which exist in French written words was presented first. She read all of these syllables without comment; her pronunciations corresponded with those shown by Dérouesné and Beauvois except for spe which she read as /speɪ/, then corrected to /spə/. When presented with the list of consonant clusters which do not exist in French written words she said immediately "I cannot read these - they are funny things. I would not know how to say them." She declined to pronounce any of them. LB, in fact, pronounced more of this type of nonword than did this normal reader. It is likely that LB's better performance on syllables which occur in French written words is due to the fact that these syllables are easier to pronounce in isolation than those which do not occur in French written words.

7 Henderson (1982) states that phonotactic "rules" are hardly "rules" but are simply derived from the observation that "certain patterns do not in fact occur", although "prohibited sequences are generally difficult to articulate". This point is even more pertinent to a discussion of orthographic "rules" or "orthographic legality". Illegal sequences of letters are simply those which do not occur in the English language.

Chapter 4

CASE REPORTS

4.1 Introduction to Case Reports I-III: patients who produce no (or almost no) output from the phonological route

One way in which patients who have sustained damage leading to impairment of the phonological route differ from one another is in the extent to which residual activity of this route can be observed. Some patients produce no output from the phonological route. Responses to nonwords are either omissions or lexicalisations. The mechanism by which the latter type of response is produced is assumed to involve processing by the lexical-semantic or direct routes, the whole word recognition system being accessed by a graphemic approximation to a real word. It is difficult to explain such responses as being the output of the phonological route itself, except as occasional translation errors which fortuitously result in a real word output, if the autonomy of lexical and non-lexical routes is maintained. The possibility of approximate phonological access to whole-word phonology is raised by the findings of Dérouesné and Beauvois (1985) relating to the pseudohomophony effect. The possible mechanism by which pseudohomophones which are not visually similar to the stimulus are read, involves an imperfect phonological representation being fed back from the response buffer into the oral word representation system where it obtains a real word match to which it approximates phonologically. This is the only route by which, according to the standard model, such an effect could be produced although it is far from satisfactory and raises the question of how the imperfect response is recognised as such and not output directly when it reaches the response buffer.

If this is the way in which lexicalisation responses are produced then patients who make a high proportion of lexicalisation responses to nonwords should be surely sensitive to pseudohomophony since approximate phonological matches should be easier to access for pseudohomophonic stimuli. The responses of DP and TW indicate that this is not the case. Furthermore, an examination of the lexicalisation errors shows that it is much easier to demonstrate visual than phonological similarity between target and response. DP made a total of 170 lexicalisation responses all of which bore some visual resemblance to the target and all but 17 of which satisfied the criteria for categorising a word reading error as visual. In cases where nonwords were pseudohomophones, the response was usually a visually similar but not homophonous real word. Such responses (e.g. akt -> "ask", madjik -> mandril) would surely be unlikely if lexicalisations were the result of approximate phonological access. TW made a total of 224 lexicalisation errors responses, of which 209 are classified as visually similar to the stimulus. When patients are efficient at lexical decision tasks it is improbable that they do not recognise the nonword as such. The activation of an entry in the whole word recognition system occurs subsequent to the failure to obtain an output from or possibly even to access the phonological route. This interpretation is borne out by demonstrations of awareness of the nonword status of the stimulus and dissatisfation with the lexicalisation response by phonological dyslexic patients who are able to perform lexical decision tasks efficiently. This account of lexicalisations requires that the visual word representation system is able to respond to a graphemic stimulus which only approximates to a word. The ability of this system to make available a word representation in response to a visually similar word is a prerequisite for the occurrence of visual errors, whichever account of such errors is preferred (see discussion of visual errors in Chapter 2). Therefore one would expect patients who respond to nonwords with lexicalisations and who also make reading errors on words to produce a proportion of visual errors in response to words. This is indeed the case; (patterns of error are discussed in Chapter 5).

Detailed investigation of word reading behaviour in such patients is of value in establishing the extent to which the lexical and phonological routes are independent. Furthermore, the total inability to use the phonological route in cases where there is impairment of the direct or the lexical-semantic route allows investigation of the operation of the single remaining route in isolation.

With regard to establishing the precise locus of impairment within the phonological route and providing more precise specifications of the type of phonological dyslexia present, the nonword reading behaviour of such patients is not revealing. It is probable that the total lack of output is the result of a lesion of one of the pathways between subsystems (or of complete loss of use of a subsystem which cannot be by-passed) rather than to the inadequate operation of a subsystem which would be expected to result in output, albeit incorrect, from the route. It is possible to specify the lesioned pathway only if the ability to access one or more subsystems can be demonstrated by the use of tasks which do not require pronunciation of nonwords but nevertheless utilize pathways present within the phonological route. It may also be possible to demonstrate the sparing of one or more subsystems by the use of non-reading tasks which tap such abilities in isolation (for instance the Sound Blending task) although, as noted earlier, failure to perform such tasks may be due to additional task demands. In the case of the Sound Blending task, for example, there is an involvement of auditory short term memory and the possibility of failure due to memory impairment must be considered.

The first 3 case studies present patients in whom the phonological route is totally or almost totally abolished.

Case I, DA, may be described as a deep dyslexic. Her ability to read nonwords correctly is nil and the majority of her responses to nonwords are omissions. There is no evidence that the direct route is functional in this patient and the nature of the additional impairments to the lexical-semantic route which are responsible for DA's pattern of reading behaviour are discussed.

Case II, DP, and Case III, TW, rarely produce a correct nonword response but both tend to respond with lexicalisations more often than omissions. The sparing of phonological skills is investigated in these patients through tasks which do not require the reading aloud of nonwords. However, it is impossible to specify the locus of the lesion within the phonological route in cases where nonword reading ability is so severely impaired.

There is clear evidence that TW is able to use the direct route when reading aloud words. In the case of DP the evidence is less easy to interpret although it seems probable that the direct route is intact. The reading performance of patients who read words using this route is relevant to the issue of the locus of the morphological decomposition system and the reading performance of and errors made by both patients are considered in relation to this issue.

4.2 Case Report I: DA

4.2.1 Neurological background

DA is a 46-year old, right-handed woman who sustained a CVA in November 1982, one week after the birth of her son. She presented with a right hemiparesis and dysphasia which developed gradually, without loss of consciousness and was admitted to Selly Oak Hospital for investigation. EEG indicated gross left hemisphere abnormality and a brain scan and left carotid angiography revealed an area of infarction in the territory of the left middle cerebral artery. Neurological examination revealed diplopia and a divergent squint. The right hemiparesis has now resolved.

4.2.2 Aphasia and dysgraphia

DA was severely aphasic. Some recovery of spoken language abilities has taken place but DA still has severe expressive language problems and continues to attend speech therapy sessions. Her spontaneous speech consists mainly of single content words and contains very few instances of the use of grammatical constructions. Asked to describe the "Cookie Theft" picture in the BDAE she said "Boy he's .... Oh God .... up .... (Examiner: "Yes, he's up.......") on the chair, no ..... (Examiner: "stool"). Biscuits .... (Examiner: "What else is happening?") Er .... the water .... er .... down .... water. Lady .... er ..../plætz /, er, plates. (Examiner: "What's she doing to the plates?") Tea, oh no, I don't know. (Examiner: "What's the girl doing?") Sister .... er, biscuits." The longest phrase is

3 words in length and melodic line is limited to short phrases and stereotypes. She scored above the sixtieth percentile on all auditory comprehension subtests of the BDAE, and above the fiftieth percentile on the repetition subtests and responsive and animal naming subtests. Confrontation naming is more severely impaired, the score placing DA just above the thirtieth percentile on this subtest. Reading comprehension is well-preserved at the single word level, maximum scores being obtained on the symbol discrimination, word recognition and word-picture matching but very impaired at the sentence level, DA's score on the sentences and paragraphs subtests placing her on the thirtieth percentile. She was unable to recognize any oral spellings. Oral reading was at zero at the sentence level and impaired at the word level, DA's score of 6 on this subtest placing her below the fiftieth percentile. Two literal and 8 verbal paraphasias were recorded. A copy of the BDAE subtest summary profile obtained in June 1984 is provided in Appendix I. The profile is compatible with a diagnosis of Broca's aphasia.

There is an accompanying phonological dysgraphia. DA makes no semantic errors in written spelling but shows a significant difference between performance on words and nonwords (she wrote 9/10 simple high frequency words and 0/10 matched nonwords). DA shows a significant effect of Part of Speech in written spelling tasks, with Nouns (16/25) being written more effectively than Adjectives (7/25), Verbs (5/22) and Function Words (4/28). There is also a strong effect of imageability on performance with more high-imageable (10/21) than low-imageable (2/21) words being written correctly. The majority of errors are visually similar to the target but are not phonetically acceptable. Inflectional, Morphological and Function Word Substitution errors occur in smaller proportions. Equal proportions of error responses form words and nonwords.

The surprising absence of semantic errors in DA's writing responses (surprising because semantic errors account for 38% of DA's reading error responss and involvement of the semantic system in written spelling is demonstrated by the effect of imageability on performance) is discussed in Section 4.2.7.5. It is concluded that DA's residual ability to make sub-lexical phoneme conversions is enough to block semantic errors in written spelling tests. Although DA is clearly unable to convert a string of phonemes into graphemes, the conversion of the initial phoneme would prevent the occurrence of a semantic error in many cases.

4.2.3 **Educational and occupational background**

DA had received 10 years schooling and had been employed in unskilled and semi-skilled factory work prior to her CVA. She had, however, read a great deal, enjoying historical and detective novels. She particularly liked reading Agatha Christie detection and has a collection of almost all this author's novels.

4.2.4 **Neuropsychological baseline tests**

The results of neuropsychological background tests administered in May/June 1984 show extremely impaired naming ability (10/60 on the Boston Naming Test) and severe impairment of auditory comprehension as measured by the shortened version of the Token Test on which DA scored 14/36. DA obtained a Memory Quotient of 69 on the Wechsler Memory Scale and I.Q. equivalents of 82 on the spoken version and 91 on the written version of the PPVT.

4.2.5 Reading, and repetition tests

The results of reading and repetition tests are shown in Tables 4.2.1 to 4.2.8. A transcription of DA's reading of the passage of text is provided in Appendix II. Error types are shown in Tables 4.2.9 to 4.2. 11

Figure 4.2.1 shows the effect of word length on reading speed. Figures 4.2.2 to 4.2.5 show graphically the proportions of different types of reading responses to words and nonwords (major error categories only).

Table 4.2.1 READING AT THE SINGLE LETTER LEVEL

Test		Number Correct	Percentage Correct
Single letter naming	n = 26	7	27
Single letter sounding	n = 24	3	13
Single letters from a string	n = 20	8	40
Cross-case letter matching	n = 58	57	98

Table 4.2.2 READING AT THE SINGLE WORD LEVEL

Test	Number Correct	Percentage Correct	Significant effect of Variable
Easy lexical decision n = 50	46	92	
Difficult lexical decision n = 40	21	53	
Imageability (standard)			
High Imageable n = 20	8	40	+
Low Imageable n = 20	2	10	
Part of speech (easy)			
Noun n = 20	12	60	+
Verb n = 20	5	25	
Adjective n = 20	9	45	
Function word n = 20	5	25	
Part of speech (revised)			
Noun n = 25	11	44	-
Verb n = 23	8	35	
Adjective n = 25	10	40	
Function word n = 37	11	30	
Regularity of spelling (standard)			
Regular n = 39	8	21	-
Irregular n = 39	5	13	
Frequency			
High Frequency n = 23	10	43	-
Low Frequency n = 23	4	17	
Word length			
3-letter n = 10	0	0	-
4-letter n = 10	3	30	
5-letter n = 10	2	20	
6-letter n = 10	0	0	
7-letter n = 10	0	0	
8-letter n = 10	1	10	
Presence of Suffix I			
Suffixed n = 30	3	10	-
Unsuffixed n = 30	8	27	

Table 4.2.3 COMPREHENSION TESTS

Test	Number correct	Percentage correct
Synonym matching		
High Imageable n = 38	34	89
Low Imageable n = 38	6	16
Semantic Probe n = 16	15	94
Comprehension of functors n = 18	16	89

Table 4.2.4 TEST OF MORPHOLOGICAL KNOWLEDGE

Test	Number correct	Percentage correct
Single word test n = 32	19	59

Table 4.2.5 TESTS OF NONWORD PROCESSING

Test	Number correct	Percentage correct	Significant effect of Variable
Reading aloud			
Easy Lexical Decision			+
Words n = 25	14	56	
Nonwords n = 25	0	0	
Nonwords synthesised from words			
with colour cue n = 10	0	0	-
without colour cue n = 10	0	0	
Segmentable words			
Visual mode n = 30	28	93	+
Auditory mode n = 30	3	10	
Hidden words n = 20	18	90	
Sound Blending I			
Words n = 24	9	38	+
Nonwords n = 8	0	0	
Sound Blending II n = 35	9	38	+
Consistent and Inconsistent nonwords			
With consistent segment n = 15	0	0	-
With inconsistent segment n = 15	0	0	
Reading by analogy I:			-
Deletion			
Type A nonwords n = 15	0	0	
Type B nonwords n = 20	0	0	
Reading by analogy II:			
Substitution			-
Type A nonwords n = 14	5	36	
Type B nonwords n = 14	2	14	
Pseudohomophony I			
Pseudohomophones n = 15	0	0	-
Non-pseudohomophones n = 15	0	0	
Inappropriately suffixed nonwords n = 25	0	0	-
Affixes in isolation n = 10	0	0	-

Table 4.2.6 READING ALOUD WORDS AND NONWORDS OF DIFFERENT STRUCTURE

Type	Percentage of words correct	Percentage of nonwords correct
A	10	0
E	30	0
F	40	0
G	10	0

n = 10 in each list

Table 4.2.7 SILENT TESTS OF PHONOLOGY

Test	Number correct	Percentage correct
Silent test of phonology I		
Nonword n = 50	7	14
Regular word n = 50	18	36
Irregular word n = 50	21	42

Table 4.2.8 TESTS OF REPETITION ABILITY

Test	Number correct	Percentage correct
Pseudohomophony I		
Words n = 15	10	67
Nonwords n = 15	9	60
Easy lexical decision		
Words n = 25	23	92
Nonwords n = 25	20	80
Nonwords of different structure		
Type A n = 10	7	70
Type B n = 10	7	70
Type C n = 10	7	70
Type D n = 10	6	60
Type E n = 10	6	60
Type F n = 10	9	90
Type G n = 10	8	80

Table 4.2.9 READING ERRORS - WORDS

		Number of errors	Percentage of errors
Visual		30	15
Sharing initial letter(s) with stimulus	16		
Sharing init. & fin. letter(s) with stimulus	9		
Sharing final letter(s) with stimulus	3		
Sharing letter(s) not in corresponding psns.	2		
Visual or Semantic		3	2
Visual then Semantic		1	1
Derivational		5	3
Derivational or Inflectional		6	3
Inflectional		40	20
Nouns	31		
Verbs	4		
Adjectives	5		
Function Word Substitutions		21	11
Visually similar	11		
Visually dissimilar	10		
Semantic		74	38
Associative	31		
Shared feature superordinate	9		
Shared feature subordinate	4		
Shared feature coordinate	30		
Other		16	8
Perseverative	3		
Possibly visual, not satisfying criteria	7		
Completion	4		
Phonemic paraphasias	2		
TOTAL ERRORS		196	
Words misread		183	27
Omissions		292	44
Words read correctly		193	29
TOTAL PRESENTED		668	
Error corrected	8		
Additional errors due to multiple responses	5		

Table 4.2.10 READING ERRORS NONWORDS

		Number of errors	Percentage of errors
Lexicalisations		16	94
Visually similar	13		
Visually distinct	3		
Other		1	
TOTAL ERRORS		17	
Nonwords misread		17	10
Omissions		152	90
Nonwords read correctly		0	0
TOTAL PRESENTED		169	

Table 4.2.11 TEXT READING ERRORS

	Number of errors	Percentage of errors
Errors on content words (n = 56)	28	50
Errors on function words (n = 69)	44	64

Fig.4.2.1 Word length and reading speed : DA

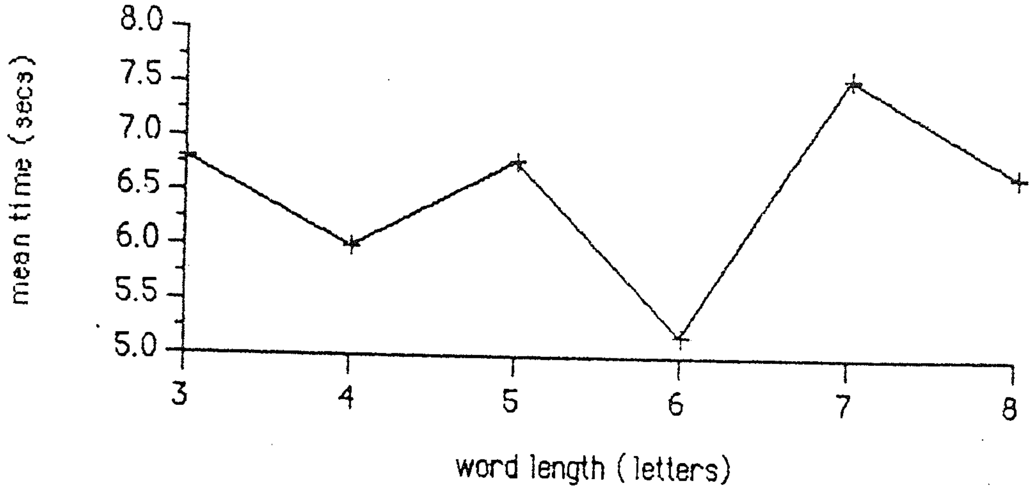


Fig.4.2.2 Reading responses to words : DA

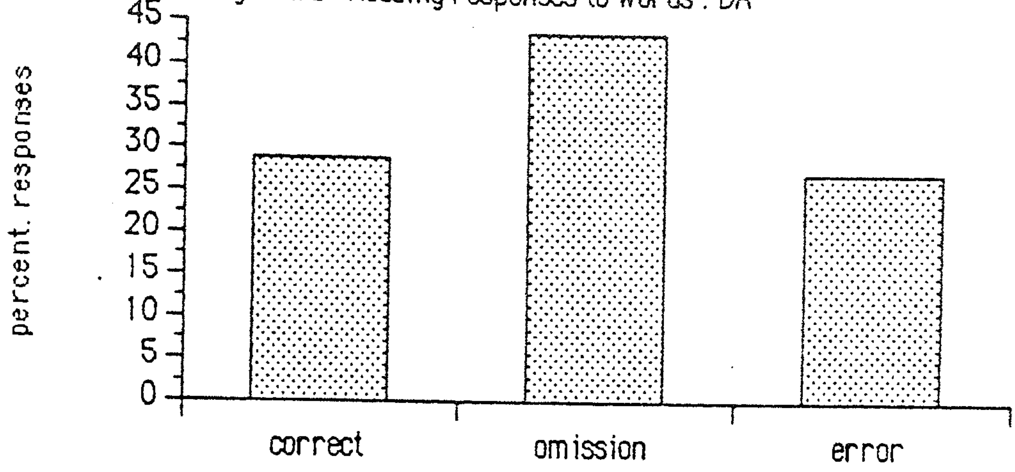


Fig.4.2.3 Reading responses to nonwords : DA

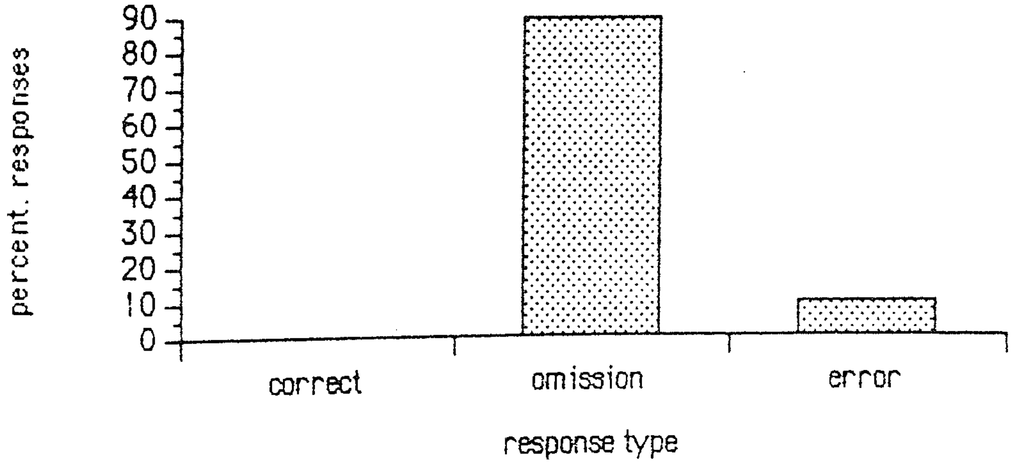


Fig. 4.2.4 Types of error response to words : DA

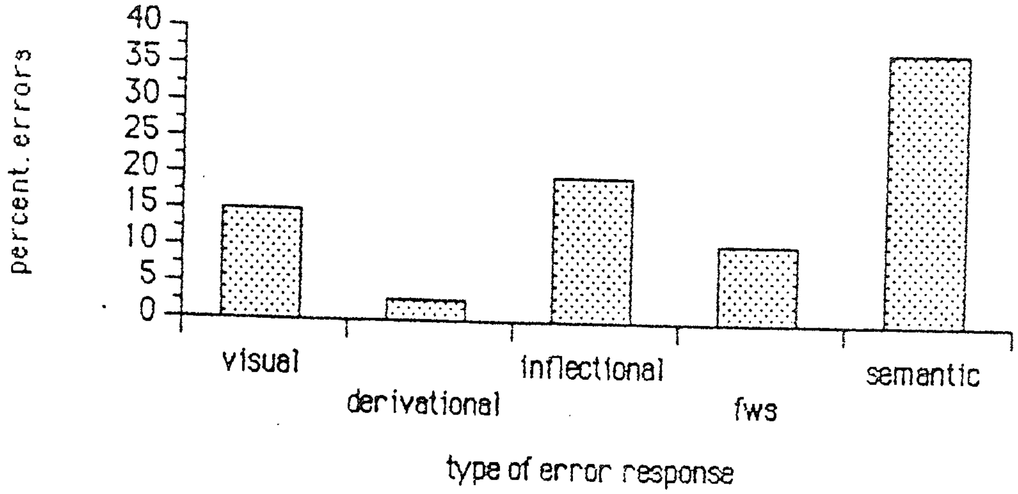
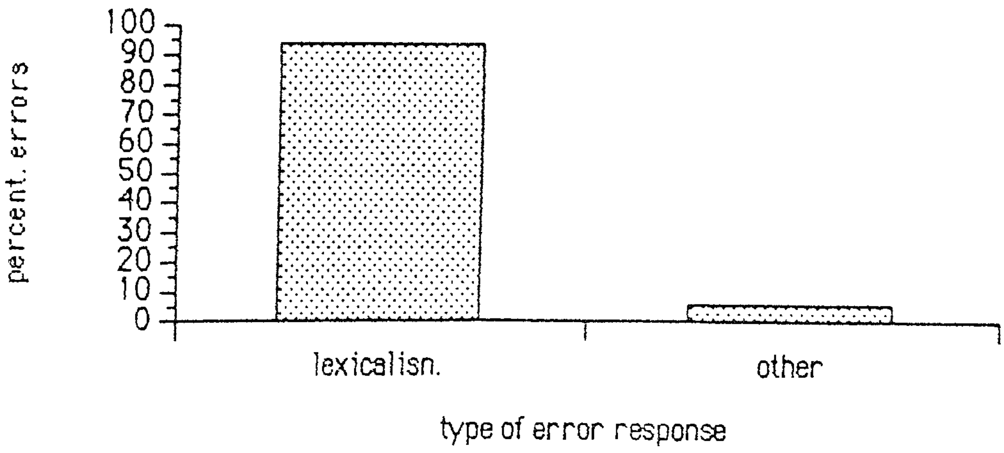


Fig. 4.2.5 Types of error response to nonwords : DA



4.2.6 Analysis of Test Results

4.2.6.1 Reading at the single word level

Chi-squared analysis shows a significant diference between the reading of high-imageable and low-imageable words (X^2 (1df) = 4.8, $P<.05$). In the Part of Speech (easy) Test, Nouns are read significantly better than are Verbs (X^2 (1df) = 5.0, $P<.05$) and Function words (X^2 (1df) = 5.0, $P<.05$). In the Revised Part of Speech Test, a similar numerical pattern is observed but comparison of performance on Nouns and Verbs (X^2 (1df) = .4, $P>.05$) and Nouns and Function Words (X^2 (1df) = 1.3, $P>.05$) shows that differences do not reach significance. Unsuffixed words are not read significantly better than suffixed words (X^2 (1df) = 2.8, $P>.05$), nor are high frequency words read better than low frequency words although this difference approaches significance (X^2 (1df) = 3.7, $P>.05$). There is no significant difference between reading of regular and irregular words (X^2 (1df) = .8, $P>.05$). There is no effect of word length on reading accuracy (Kendall's S = -2, P .5). The mean times taken to read words of different length are shown in Figure 4.1. There is no significant correlation between mean reading time and word length (Kendall's S = 2, $p>.5$). Performance on the Easy Lexical Decision Test yields a Hit Rate of .96 and a False Alarm Rate of .12 (d' = 3.6) and on the Difficult Lexical Decision Test a Hit Rate of .25 and a False Alarm Rate of .2 (d' = .32).

4.2.6.2 Comprehension Tests

Significantly more High Imageable than Low Imageable synonym pairs were judged correctly (X^2 (1df) = 41.4, $P<.001$). Performance on the Semantic Probe Test is significantly above chance (chance = 8 ± 4) Performance on the Comprehension of Functors Test is also significantly above chance (chance = 9 ± 3).

4.2.6.3 Test of Nonword Processing

Nonword reading is at zero on all but the second Reading by Analogy Test. Word reading scores are significantly higher than nonword scores in the Reading Easy Lexical Decision Test (X^2 (1df) = 19.4, $P<.001$) and the Words and Nonwords of Different Structure Test ($Z = 2.8$., $P < .01$).
Performance is at zero on the Nonwords Synthesised from Words Test and on both Nonword Tests of Sound Blending, performance on nonwords being significantly poorer than performance on words on the Sound Blending I Test (X^2 (1df) = 4.2, $P<.05$). The score on the visual version of the Segmentable Words Test is significantly higher than the score on the auditory version (X^2 (1df) = 41.7, $P<.001$). On the Reading by Analogy II Test there is no significant difference between performance on Type A and Type B nonwords (X^2 (1df) = 1.72, $P>.05$). Performance on this test is significantly better than on the Reading by Analogy I Test $Z = 2.7$, $P<.01$). Performance on The Nonword Version of the Silent Test of Phonology is significantly poorer than performance on the regular word version (X^2 (1df) = 6.45, $P<.05$) and the irregular word version (X^2 (1df) = 9.7, $P<.01$) although d' is low on all 3 versions (Nonword Hit Rate = .24, False Alarm Rate = .16, d' = .28; Regular Word Hit Rate =

.048, False Alarm Rate = .12, d' = 1.28; Irregular Word Hit Rate = .36, False Alarm Rate = .04, d' = 1.5).

4.2.6.4 Tests of Repetition Ability

There is no significant difference between scores on word and nonword repetition in the Pseudohomophony I Test (X^2 (1df) = .14, $P>.05$) and the Easy Lexical Decision Test $Z = .8$, $P>.05$). There is no significant effect of stimulus type on repetition performance in the Nonwords of Different Structure Test (X^2 (6df) = 2.8, $P>.05$

4.2.6.5 Reading Errors: Words

The highest proportion of errors (38%) are semantically related to the stimulus. Significantly more semantic than visual (X^2 (1df) = 18.6, $P<.001$) and than derivational and inflectional (X^2 (1df) = 4.2, $P<.05$). errors are made. There is a highly significant difference between the number of inflectional and the number of derivational errors made (X^2 (1df) = 13.6, $P<.001$). There is no significant difference between the number of semantic errors classified as associative and the number classified as shared feature (X^2 (1df) = 1.9, $P>.05$) nor between the number of Function Word Substitutions which are visually similar to the target and the number which are visually dissimilar (X^2 (1df) = .05, $P>.05$).

4.2.6.6 Reading Errors: Nonwords

All but one of DA's error responses to nonwords are lexicalisations, the latter thus account for 94% of her error responses. The majority of lexicalisations (81%) are visually similar to the stimulus. The difference between the number of visually similar and the number of visually distinct lexicalisations is significant (χ^2 (1df) = 6.25, $P < .05$).

4.2.6.7 Reading Errors: Text

The number of errors and omissions made on the stems of content words does not differ significantly from the number of errors and omissions made on function words in reading aloud the passage of text (χ^2 (1df) = 2.5, $P > .05$).

4.2.7 Discussion of reading impairment

4.2.7.1 The presence of deep dyslexia

The high proportion (38%) of semantic error responses made by DA in conjunction with the presence of visual, derivational and inflectional errors and function word substitutions, an imageability effect, a part of speech effect in which nouns are read better than are verbs or content words and an inability to read nonwords indicates that this is a typical case of deep dyslexia as defined by Coltheart (1980b).

4.2.7.2 Reliance on the lexical-semantic route

The presence of semantic errors reflects reliance on the lexical-semantic route; the effect of imageability provides further evidence of such reliance and the part of speech effect (N V; N F) is compatible with it. Overall performance on the synonym matching task (53%) correct shows evidence of impairment within the semantic system, but there is no evidence of a functional direct route in the comparison of reading and matching scores. DA found this reading task extremely difficult. She attempted to read 20 of the 76 items in the test and produced correct pronunciations for only 3 of them (15% correct). The test was then discontinued at her request. Of the 20 items presented 9 were high-imageable and 11 low imageable words. Although a direct comparison cannot be made in view of the discontinuation of the reading test, it seems improbable that a score exceeding the score on the matching task would have been obtained. When results are summed across all reading tests, DA was able to read only 29% of the words with which she was presented.

4.2.7.3 The abstract letter recognition system

According to the model proposed by Marshall (1984b), the whole word recognition system may be accessed without the involvement of the abstract letter recognition system. DA performed poorly on tasks requiring the naming of single letters. However, she was able to match letters of different case efficiently (being 98% correct on this task). This ability indicates that the letter recognition system is intact and suggests that the impaired ability to name letters aloud is better regarded as a specific form of anomia involving a separate store of phonological representations of letter names. Abstract letter identification may or may not precede word recognition in DA's case.

4.2.7.4 The morphological decomposition system

Since DA relies on the lexical-semantic route for reading aloud, the occurrence of inflectional and derivational errors (which together account for 26% of word reading errors) is not enlightening with respect to the issue of the location of the morphological decomposition system. The proportion of inflectional and derivational errors is higher than the proportion of visual errors (the latter account for 15% of the total) but derivational and inflectional errors do not occur more frequently on affixed words. However, the fact that significantly more errors are inflectional than are derivational suggests that these are genuine error categories and that the errors are not visual in origin. The distinction between inflectional and derivational errors is a linguistic one and if putative errors of this type were visual in origin one would expect roughly equal numbers of errors in the 2 categories. The mechanism by which an affix is gratuitously added to a non-affixed word is even less easily explained than that by which an affix is deleted or substituted. By far the largest proportion of errors in these categories is accounted for by addition (most frequent) or deletion of the plural marker "s"; on two occasions error resulted from the production of a plural rather than a singular form when plural formation was irregular (<u>tooth</u> $\rightarrow$ "teeth": <u>child</u> $\rightarrow$ "children"). These latter errors suggest that the singular/plural form confusion stems from a morpheme-based system which contains a list of legal affixes or from confusion at the whole word level; such errors are not compatible with the notion of systems which strip and reassemble affixes on the basis of purely visual information. DA's total inability to read affixes presented in isolation and inappropriately suffixed nonwords provides no evidence to support Job and Sartori's (1984) notion of representation of affixes within a visual recognition system, although it is possible that the representations for affixes may be selectively destroyed.

4.2.7.5 The impairment within the semantic system

Shallice and Warrington (1982) put forward the possibility of differentiating between "input" and "output" deep dyslexics. This distinction is discussed by Barry and Richardson (1982); a related hypothesis has been presented in earlier discussion of error categories. According to this hypothesis, an "input" deep dyslexic should tend to make shared-feature rather than associative semantic errors, while "output" deep dyslexia is compatible with a high proportion of associative errors. It is not possible to assign DA to one or other of these categories; her test results and pattern of errors suggest difficulties in accessing semantic representations and addressing the oral word representation system by means of semantic representations.

The effect of imageability on word reading performance indicates that, in DA's case, the store of representations for low-imageable words is more severely damaged than is the store of representations for high-imageable words. That the impairment is at the stage at which a semantic representation is obtained rather than at the stage at which output phonology must be accessed by a semantic representation is suggested by the poor performance on low-imageable in comparison with high-imageable pairs in the synonym matching task. DA's high success rate (94% correct) on the semantic probe test may be attributed to the high imageability of all words in this test. Performance on the reading aloud and comprehension of functors tests however presents a conflicting picture. Nouns are read significantly better than function words in the easy Part of Speech test. It has been suggested that the reading of text may rely more heavily on the semantic system than does the reading of single words. In an attempt to read a passage of text, DA made more errors or omissions in response to function words than in response to content words, although as the passage contains more function than content words, this difference does not reach significance. The occurrence of a number of function word substitution errors of which half are visually dissimilar to the target suggests that these errors may also arise as the result of a selective impairment of this word-class within the semantic system. DA demonstrated fairly good comprehension of functors (83% correct) and of plural inflections (100% correct), thus presenting with a pattern compatible with output deep dyslexia in respect of the reading of functors. If semantic representations for different word classes are stored separately within the semantic system, the possibility of different patterns of impairment for different word classes cannot be ruled out. Alternatively, the relatively high meaningfulness of the items in the test may have facilitated comprehension.

A further conflicting piece of evidence which would be more compatible with DA's primary difficulty being in accessing an oral word representation by means of a semantic representation is that no semantic errors occur in written spelling tasks, in spite of the presence of an imageability effect which indicates involvement of the semantic system in writing tasks. However, it is possible that DA's residual, though greatly impaired, ability to make sub-lexical phoneme-grapheme conversions, as evidenced by some ability to write letters in response to dictated phonemes, is enough to block semantic errors in written spelling tasks.

Proportions of semantic errors of different types are compatible with the explanation of DA's semantic errors resulting from impairment at two loci. DA makes more shared-feature (58% of semantic errors) than associative (42% of semantic errors) semantic errors, but this difference does not reach significance.

4.2.7.6 **The nonword reading impairment**

DA's reading of nonwords is at zero on all but one test and the failure to read any nonwords in the shortened "nonwords of different structure test" renders the test useless in establishing the precise locus of impairment. Since all but one of DA's responses to items in this test are omissions, no comparisons of number of items of different types attempted or of error types on different items can be made. The results of tests of phonological skills operating in isolation rather than in the reading of nonwords are therefore of particular importance in DA's case. Abstract letter identification appears to be possible, as mentioned earlier, in view of DA's ability to match letters of different case, even though the ability to name letters is severely impaired. DA retains the ability to segment letter strings when the units of analysis are words as shown by her success rate of 90% on the hidden words and 93% on the segmentable words test. That the latter task was not performed by an auditory subsystem is clear from the extremely poor score on the auditory version of this task (10% correct), a comparison of the two scores revealing a highly significant difference in performance in the two modalities. It is, however, possible that these tests involve a minimal ability to segment and may be performed as visual word recognition tasks in which words must be recognised against a background of visual noise. To devise a test of pure orthographic resegmentation ability is extremely difficult. Patterson and Marcel have now developed such a test (see Chapter 1, Note 3) although it may be possible to obtain a reasonable score on this test by means of a strategy of approximate visual access. Another possible test is to ask the patient to mark off the letters in words and nonwords which correspond to a single sound. DA was presented with the matched lists of words and nonwords of different structure described in Chapter 3, Section 2, handwritten, lower case on a sheet of paper, and instructed to perform this task. This task was chosen in preference to the task sometimes used in assessment of developmental dyslexia in which the child is asked to tap out the constituent sounds of the word (e.g. Thomson, 1984) since the latter is most appropriate when the word to be segmented is presented auditorily. DA was almost unimpaired on this task, scoring 39/40 on the word list and 40/40 on the nonword list. Her only error was in failing to recognize the digraph ai in bait which she segmented thus b - a - i - t. Thus the resegmentation system is not implicated as the primary locus of impairment in this patient. DA's severely impaired ability to sound visually presented letters (13%) correct is suggestive of a deficit in the phoneme allocation system but does not provide conclusive evidence since, as noted in earlier discussion, the ability to sound letters may be impaired in a patient who is able to read nonwords. I have argued elsewhere (Bradley and Thomson, 1984) that the ability to read nonwords by analogy with real words reveals some residual knowledge of grapheme-phoneme conversion rules; DA showed a limited ability to read nonwords using the "by analogy" strategy which will be discussed in the following paragraph. DA was unable to blend auditorily presented phonemes which formed nonwords; she was able to recognise only 38% of words presented as strings of phonemes. This suggests that the blender is severely impaired. DA's performance was not improved by pseudohomophony of the stimuli. Although repetition ability is not perfect, DA's ability to repeat 60-90% of nonwords which she was totally unable to read indicates that the problem is not simply one of output. There is no significant difference between DA's ability to repeat words and her ability to repeat nonwords nor is there any effect of varying the structure of nonword stimuli in the repetition task. The ability to compare word or nonword phonology and to judge whether or not two items sound alike in the silent tests of phonology is impaired in word and nonword tests. DA was unable to judge whether or not a nonword was pronounceable in the Silent Test of Phonology II.

When induced to use a "reading by analogy" strategy in the Substitution Test (see Chapter 3, Section 3.1.5.11) DA was able to pronounce 7/28 (25%) of nonwords correctly. The method of administration of Reading by Analogy I and II differed slightly in DA's case. She was unable to read several of the words on initial presentation. These words on which she failed were given to her and she was asked to repeat them. During the administration of test items she was not given any help with word reading. The test does not require that the real word stimuli are read aloud before substitution or deletion of a letter but DA did in fact read each word before pronouncing a nonword. On no occasion when she could not pronounce the real word correctly did she succeed in reading the target nonword. For example, the word <u>king</u> was not read on initial presentation; the correct pronunciation was given and DA repeated it. During the test she read the word aloud once and was able to follow its pronunciation with the correct nonword response. On another occasion during the test she was unable to read the word aloud and on this occasion she was not able to produce the required nonword response. This pattern suggests very strongly that DA is manipulating post-lexical phonology rather than visually segmenting the word into subword units. The pattern is compatible with Bradley and Thomson's original account which postulates a pathway between the oral word representation system and the set of grapheme-phoneme correspondence rules. It is less easily explained in terms of Barry and De Bastiani's (in press) account in terms of the lexical analogy model proposed by Marcel (1980) since according to Marcel identification of subword units takes place prior to the assignment of phonology to these units and does not require that whole-word phonology be obtained before the phonology for segments of the word can be accessed. Note that, in spite of DA's pronunciation of the real word, the task is unlikely to be performed by means of segmentation of the auditory representation of the word she had spoken. Her performance on the auditory version of the Segmentable Words Test was very poor (10% correct) and it has been established that segmentation into words is easier than segmentation into phonemic units (Baron and Treiman, 1980). DA's performance on this test thus reveals some knowledge of grapheme-phoneme correpondences and indicates that the phoneme allocation system is not totally non-functional. Her ability to pronounce the nonwords in this test as synthesised wholes suggests the retention of some ability to blend phonemes. Minimal blending ability is required in reading the nonwords in this test but no ability to blend phonemes in nonwords was apparent in the auditory Sound Blending tests. These tests do however require auditory processing of phonemes prior to blending and therefore impose a load on auditory short-term memory. DA has a digit span of 4; this span indicates some impairment of auditory short-term memory.

A difficulty in the interpretation of DA's test results arises in connection with her differing performance on the two "Reading by Analogy" tests. DA obtained her score of 25% correct on the second reading by analogy test in which one phoneme must be substituted for another. In the first test in which a single phoneme must be deleted in order to form a nonword DA's score was zero. Yet, at least where Type A nonwords are concerned (nonwords in which no change to remaining phonemes is necessary before pronunciation of the nonword), the Deletion Test seems a simpler one since deletion must presumably precede substitution in the Substitution Test. The tests differ in that in the Substitution Test, the phoneme requiring attention is always the initial phoneme. In the Deletion Test, the initial phoneme must be deleted in only 7 of the 35 items. It is possible that segmentation of an initial phoneme is easier than segmentation of a medial or final phoneme.

No additional evidence regarding the use of analogy strategy is provided by the Consistent and Inconsistent Nonwords Test since DA was unable to read any item in this test.

4.2.7.7 Deep and Phonological Dyslexia

4.2.7.7.1 Qualitative differences in performance

The validity of distinguishing these two types of dyslexia has been queried in earlier discussion and the conclusion was that the distinction cannot be theoretically justified. Yet DA's reading performance does, like that of many other "deep" dyslexics, differ qualitatively from that of many "phonological" dyslexics in the following ways:

- i) She makes a substantial proportion of semantic errors.
- ii) Her word reading ability (29% correct overall) is more severely impaired than that of most phonological dyslexics and than that of all the phonological dyslexics described in this work.
- iii) A high proportion (44%) of her responses to visually-presented words are omissions.
- iv) Nonword reading is at zero.
- v) The majority of responses (90%) to visually-presented nonwords are omissions.

Additional characteristics of DA's pattern of performance which are not typical of other reported cases of deep dyslexia are:

vi) The percentage of visual error responses to words is relatively low (15% of error responses). It is even lower if omissions are included in the error total. In this case 71% of words presented were not read correctly at first presentation. Visual errors account for 6% of this total while omissions account for 45%.

vii) The majority (58%) of semantic errors are classifiable as shared feature errors, although there is no significant difference between the number of shared feature and the number of associative errors.

It is not possible to explain these aspects of DA's performance by positing one impairment additional to the impairments within the phonological route and the direct route. A lesion at the point at which the representation output from the visual word recognition system must access the semantic system, could account for many of the features of the pattern of reading impairment listed but further experimental investigation of DA's residual abilities forces the conclusion that there is a further deficit or at least difference in organisation within the visual word recognition system. That the visual word recognition system is relatively unimpaired is demonstrated by DA's good performance (92% correct) on the easy lexical decision task. (It is probably that many of the words in the difficult lexical decision test did not form part of her pre-trauma vocabulary). The difficulty in obtaining the correct semantic representation to match the visual word representation which leads to the occurrence of shared feature semantic errors has already been discussed. The high proportion of omissions in response to visually-presented words could result from occasions when not even minimal semantic information can be retrieved from the semantic system. A problem with this interpretation is noted by Morton and Patterson (1980a). Difficulty in accessing the semantic system is also put forward in the account of the production of visual errors. Why does the difficulty on some occasions result in an omission and on others a visual error? Morton and Patterson's preferred account of visual errors requires the presence of a control mechanism which would sense that a code had been sent from the visual word representation to the semantic system but had failed to yield a semantic representation. The mechanism "would then initiate a second analysis of the stimulus" following which a visually similar representation would be made available in the visual word representation system. They conclude that an omission would occur if no "highly activated alternative candidate" were available but express their dissatisfaction with this account. An alternative explanation would be that the paucity of available semantic representations or the raised thresholds which render the representations inaccessible result in a failure at the same stage in the system in the processing of the visually similar alternative. In this case it would be necessary to show that visually similar alternatives could be accessed but could not be output. The same impairment would prevent the output of lexicalisation responses. Visually similar real word representations would be activated in the visual word representation system but would be "blocked" at the stage at which a semantic representation must be accessed. In this case the number of visual errors made in response to visually-presented words (30/655) and the number of visually similar words produced in response to visually-presented nonwords (13/169) should not differ significantly. Chi-squared analysis reveals that there is no significant difference between the number of visual errors on words and on nonwords (X^2 (1df) = 2.6, $P > .05$). Additionally this hypothesis predicts that DA should be able to access representations in the visual word representation system which she is not able to output.

4.2.7.7.2 **Experimental investigation of the ability to obtain** and output visually similar words.

This prediction was investigated by utilising DA's relatively well-preserved graphemic abilities. She was presented with 40 nonwords and 25 words from the structured words and nonwords test. Nonwords and words were presented separately, handwritten lower case on a sheet of paper. DA was asked to alter each nonword or word in such a way as to make it into another word which was visually similar to the original item. The task was explained using a number of demonstration items such as dot → dog and plet → pleat. DA was encouraged to find visually similar words for as many items as possible by adding, deleting or substituting letters in the original letter string. She was told to write a new word next to each item on the sheet. She was encouraged to make alterations to the stimuli presented if this would help her in the task. According to Ellis' (1982) model of spelling and writing (and reading and speaking and hearing) this task must be performed via the visual input logogen system since the link between stimulus and response must be visual and not semantic. Failure could result from a deficit in the graphemic output system but it was felt that the stimulus items should function as cues which would make failure at this stage less likely and that such a deficit should result in misspellings rather than omissions. When DA had completed a sheet she was asked to read aloud the visually similar words which she had written. On the sheet of nonword stimuli she accessed and wrote down visually similar words for 20/40 items. She was able to read aloud only 5/20 items. On the sheet of word stimuli she accessed and wrote down visually similar words for 10/25 items and read aloud only 3/10. There is no significant difference between the number of words accessed on word and nonword sheets (X^2 (1df) = .59, P$>$.05). The observation that on 22 occasions she was able to access a visually similar word which she could not subsequently output supports the hypothesis that DA is impaired in her ability to access semantic representations for items for which she has obtained a visual word representation. However, she was unable to find a visually similar word for 50% of the nonword and 60% of the word items. In order to check whether this failure was due to a deficit in the graphemic output system, DA was asked, for each of the omitted items whether she could think of a word but did not know how to write it. She indicated that she could not think of a word in each case. This inability suggests that, although the visual word recognition system is able to respond to real words efficiently (if it were not, DA should have incorrectly rejected a number of words in the lexical decision task) it does not always respond to approximations to words, and that a set of orthographic neighbours is not, in many cases, activated by a visually-presented word. Against a background of lexical analogy models, such a characteristic must be regarded as a deficit. In the context of the standard model, it is not clear that this characteristic should be thus described. It is, however, clear that failure of visual stimuli to activate orthographic neighbours and achieve approximate visual access is not an unvarying characteristic of the reading of patients who are unable to use the phonological route) as evidenced by the high proportion of lexicalisation and visual errors which some patients make) and of normal readers who have no difficulty in recognizing visual similarity between words (Dunn-Rankin, 1978).

4.2.8 Summary and conclusions

DA presents as a case of deep dyslexia as defined by Coltheart (1980b). A number of qualitative differences between DA's reading performance and that of the phonological dyslexics[1] discussed in this work are noted and it is argued that the differences in DA's reading behaviour can be attributed to impairment at two loci within the lexical-semantic route. Impairment is postulated at the point at which the representation output from the visual word recognition system addresses the semantic system and within the visual word recognition system itself. The latter impairment manifests itself in the failure of graphemic stimuli to activate orthographic neighbours. DA is unable to read any nonwords correctly. Tests which do not involve the reading aloud of nonwords provide some evidence for the spared ability to segment letter strings. There is no evidence that DA can allocate phonemes to graphemes with any degree of accuracy or that she is able to blend phonemes to form a nonword.

Notes for Case Report I

1 This statement is not intended to imly that deep and phonological dyslexica would be regarded as separate varieties of reading disorder. As concluded in Chapter 2 there is no theoretical justification for such a distinction. DA is, in fact, grouped with the phonological dyslexics for the purposes of this work and her test results appear in the summary tables in Chapter 5.

4.3 Case Report II: DP

4.3.1 Neurological Background

DP is a 53-year old right-handed woman who sustained a CVA in May, 1982. No information regarding site of lesion is available. DA presents with a right hemiplegia, aphasia, and a mild oral dyspraxia which leads to effortfulness rather than errors in verbal production. The hemiplegia necessitates writing with the non-preferred hand.

4.3.2 Educational and Occupational Background

DP has had 9 years schooling and prior to her marriage was employed in semi-skilled factory work. She read newspapers, magazines and an occasional novel. She has always enjoyed doing crossword puzzles and other word games and has attempted to regain her skills with such games since her CVA. She was, prior to her CVA, very good at spelling and, according to her husband, took care of all correspondence for the family.

4.3.3 Aphasia and Dysgraphia

DP's spontaneous speech is agrammatic and phrase length rarely exceeds 3 words. A copy of the BDAE Z-Score profile of aphasis subscores for a test administered in May 1983 is provided in Appendix I. The profile is compatible with the presence of Broca's aphasia. Scores on all auditory comprehension subtests are above the mean although indicative of some impairment (67/72 for Word Discrimination; 18/20 for Body Part Identification; 12/15 for Commands; 8/12 for complex material). Reading comprehension scores are also above the mean at the single word level, with full scores being obtained on the symbol discrimination and word recognition subtests, but the score on the sentences and paragraphs subtest drops to 3/10. Word reading is good (28/30) at the single word level but impaired (3/10) at the sentence level. Repetition is unimpaired at the single word level (10/10) and above the mean for high probability (7/8) and low probability (5/8) phrases. Occasional literal and verbal paraphasias are observed. DP's responsive naming (23/30) and body part naming (22/30) are above the mean but confrontation naming (57/105) and animal naming (6) are just below the mean.

DP's pattern of performance in written spelling suggests deep dysgraphia although the proportion of clear semantic errors is low. She was unable to write any nonwords correctly although she wrote 6/10 simple matched words and was better at writing high-imageable (10/21) than low imageable (1/21) words. She was better at writing nouns (8/10) than function words (2/10). Investigation of dysgraphic disorders is outside the scope of this work. However, the occurrence of semantic errors in written spelling has implications for the interpretation of the reading impairment. DP made 9 clear semantic errors which account for 5% of total errors (head → teeth; meat → steak; year →merry; thank → much; key → rings; folk → night; sets → chess; lush → grass; narrow → tight). A further 6 errors are probably semantic although the relationship between stimulus and response is less clear (soft → sitting; mild → rum; regular → stint; lend → read; greet → dear; men → him). She also made a number of Bizarre errors in which the response bore little or no visual resemblance to the target. These errors were examined closely for semantic relatedness to the stimulus. It was hypothesised that they might result from a semantic error followed by a misspelling of the semantically-related word. A further 7 errors were identified as possibly semantic (promise → Tellem, via "Don't tell them"; strange → oddenly, via "odd", "oddly"; easel → arent, via "artist"; suggest → comint, via "comment"; protect → timint, via "timid"; stumble → tontting, via "tottering"; oil → rorive, via "olive"). If these errors are indeed semantic, the total for this category rises to 22 (13% total errors). Other Bizarre errors[1] may in fact be semantically related to the stimulus although the relationship has not been established.

4.3.4 Neuropsychological Baseline Tests

DP's score on the Boston Naming Test is very poor (19/60). The test was discontinued at item 49. Responses to the 30 failed items consist of 15 omissions and 15 error responses of which two are inflectional (tree → "trees"; bench → "benches") and the remaining 13 (87% of errors) (e.g. octopus → crab) are semantic[2]. One possible semantic error (mushroom → "toadstool") is scored as correct.

DP obtained a Memory Quotient of 84 on the Wechsler Memory Scale; her digit span is 5 forward and 3 backward. A score of 16/36 on the shortened version of the Token Test indicates a severe impairment of comprehension when the latter is dependent on prepositional relationships. Scores on the PPVT also indicate impairment of comprehension at the single word level. DP has an I.Q. equivalent of 77 on the spoken and 69 on the written version of the Peabody.

4.3.5 Reading and Repetition Tests

The results of reading and repetition tests are shown in Tables 4.3.1 to 4.3.9. A transcript of DP's reading of the passage of text is provided in Appendix II. Error types are shown in Tables 4.3.10 to 4.3.12. Figure 4.3.1 shows the effect of word length on reading speed. Figures 4.3.2 to 4.3.5 show graphically the proportions of different types of reading responses to words and nonwords (major error categories only).

Table 4.3.1 READING AT THE SINGLE LETTER LEVEL

Number Test		Percentage Correct	Correct
Single letter naming	n = 26	19	73
Single letter sounding	n = 24	4	17
Single letters from a string	n = 20	18	90
Cross-case letter matching	n = 58	56	97

Table 4.3.2 READING AT THE SINGLE WORD LEVEL

Test	Number Correct	Percentage Correct	Significant effect of Variable
Easy lexical decision n = 50	49	98	
Difficult lexical decision n = 40	30	75	
Imageability (standard)			
High Imageable n = 20	15	75	-
Low Imageable n = 20	16	80	
Imageability (difficult)			
High Imageable n = 20	12	60	+
Low Imageable n = 20	4	20	
Part of speech (easy)			
Noun n = 20	19	95	-
Verb n = 20	18	90	
Adjective n = 20	19	95	
Function word n = 20	16	80	
Part of speech (revised)			
Noun n = 25	24	96	-
Verb n = 23	19	83	
Adjective n = 25	21	84	
Function word n = 37	28	76	
Regularity of spelling (standard)			
Regular n = 39	28	72	-
Irregular n = 39	25	64	
Frequency			
High Frequency n = 23	19	86	-
Low Frequency n = 23	15	65	
Word length			
3-letter n = 10	6	60	-
4-letter n = 10	9	90	
5-letter n = 10	8	80	
6-letter n = 10	8	80	
7-letter n = 10	6	60	
8-letter n = 10	8	80	
Presence of Suffix I			
Suffixed n = 30	18	60	+
Unsuffixed n = 30	27	90	
Presence of Suffix II -			
Suffixed n = 28	14	50	-
Unsuffixed n = 28	13	46	

Table 4.3.3 COMPREHENSION TESTS

Test	Number correct	Percentage correct
Synonym matching		
High Imageable n = 38	34	89
Low Imageable n = 38	28	74
Semantic Probe n = 16	12	75
Comprehension of functors n = 18	18	100

Table 4.3.4 TESTS OF MORPHOLOGICAL KNOWLEDGE

Test	Number correct	Percentage correct
Single word test n = 32	11	34

Table 4.3.5 TESTS OF NONWORD PROCESSING

Test	Number correct	Percentage correct	Significant effect of Variable
Reading aloud			
Easy Lexical Decision			
Words n = 25	25	100	+
Nonwords n = 25	1	4	
Nonwords with inconsistent letters			
With inconsistent letter n = 36	1	3	-
Without inconsistent letter n= 36	3	8	
Nonwords synthesised from words			
with colour cue n = 10	4	40	-
without colour cue n = 10	1	10	
Segmentable words			
Visual mode n = 30	27	90	+
Auditory mode n = 30	13	43	
Hidden words n = 20	2	10	
Sound Blending I			
Words n = 24	17	71	-
Nonwords n = 8	4	50	
Sound Blending II n = 35	18	51	
Consistent and Inconsistent nonwords			
With consistent segment n = 15	1	7	-
With inconsistent segment n = 15	1	7	
Reading by analogy I:			
Deletion			
Type A nonwords n = 16	2	13	-
Type B nonwords n = 19	3	16	
Reading by analogy II:			
Substitution			
Type A nonwords n = 12	3	25	-
Type B nonwords n = 12	4	33	
Pseudohomophony I			
Pseudohomophones n = 15	5	33	-
Non-pseudohomophones n = 15	2	13	
Pseudohomophony II			
Pseudohomophones n = 10	3	30	-
Non-pseudohomophones n = 10	0	0	
Inappropriately suffixed nonwords n = 25	6	24	
Affixes in isolation n = 10	1	10	

Table 4.3.6 READING ALOUD NONWORDS OF DIFFERENT STRUCTURE

Type	Example	Number correct	Percentage correct
A	tad	2	20
B	ank	1	10
C	ead	2	20
D	eth	2	20
E	tood	1	10
F	dack	0	0
G	dunt	0	0
H	afe	2	20

n = 10 in each list

Table 4.3.7 READING ALOUD WORDS AND NONWORDS OF DIFFERENT STRUCTURE

Type	Percentage of words correct	Percentage of nonwords correct
A	70	20
E	70	10
F	80	0
G	50	0

n = 10 in each list

Table 4.3.8 SILENT TESTS OF PHONOLOGY

Test	Number correct	Percentage correct
Silent test of phonology I		
Nonword n = 50	22	44
Regular word n = 50	30	60
Irregular word n = 50	28	56
Silent test of phonology II n = 40	28	70

Table 4.3.9 TESTS OF REPETITION ABILITY

Test	Number correct	Percentage correct
Pseudohomophony I		
Words n = 15	14	93
Nonwords n = 15	13	87
Easy lexical decision		
Words n = 25	24	96
Nonwords n = 25	22	88
Nonwords of different structure		
Type A n = 10	10	100
Type B n = 10	10	100
Type C n = 10	8	80
Type D n = 10	7	70
Type E n = 10	10	100
Type F n = 10	9	90
Type G n = 10	10	100

Table 4.3.10 READING ERRORS - WORDS

		Number Correct	Percentage Correct
Visual		104	50
Sharing initial letter(s) with stimulus	41		
Sharing init. & fin. letter(s) with stimulus	34		
Sharing final letter(s) with stimulus	25		
Sharing medial letter(s) with stimulus	1		
Sharing letter(s) not in corresponding psns.	3		
Visual or Semantic		5	2
Derivational		14	7
Derivational or Inflectional (ing)		5	2
Inflectional		22	11
Nouns	13		
Verbs	7		
Adjectives	2		
Function Word Substitutions		9	4
Visually similar	8		
Visually dissimilar	1		
Other		50	24
Possibly visual, not satisfying criteria	8		
Completion	1		
Phonemic paraphasias	1		
Blending	2		
Visual and segmentation	1		
Regularisation	1		
Substitution, addition or deletion of word segments	26		
Literation	1		
Mixed	1		
Incomplete	5		
Unclassified	2		
TOTAL ERRORS		209	
Words misread		197	24
Omissions		13	2
Words read correctly		610	74
TOTAL PRESENTED		820	

Error corrected	4
Additional errors due to multiple attempts	8

Table 4.3.11 READING ERRORS NONWORDS

			Number of errors	Percentage of errors
Lexicalisations			170	79
Visually similar to stimulus	151			
sharing initial letter(s) with stimulus		55		
sharing init. & fin.letter(s) with stimulus		32		
sharing final letter(s) with stimulus		51		
sharing medial letter(s) with stimulus		1		
sharing letters not in corresponding posns.		12		
Visually distinct from stimulus	19			
sharing initial letter(s) with stimulus		10		
sharing final letter(s) with stimulus		3		
sharing letter(s) not in corresponding posns.		5		
sharing phoneme(s) but not letters with stimulus		1		
Incorrect nonwords			27	13
gross errors of grapheme-phoneme conversion		16		
phonemic realisation of silent <u>e</u>		1		
failure of marking function of silent <u>e</u>		3		
addition of single grapheme phoneme		1		
omission of single grapheme/phoneme		2		
substitution of single grapheme/phoneme		4		
Other			17	8
Letter identification	6			
Perseveration	4			
Complex lexicalisation	5			
Unclassified	2			
TOTAL ERRORS			214	
Nonwords misread			200	78
Omissions			30	12
Nonwords read correctly			27	11
TOTAL PRESENTED			257	
Additional errors due to multiple responses				14

Table 4.3.12 TEXT READING ERRORS

	Number of errors	Percentage of errors
Errors on stem of content words (n = 56)	13	23
Derivational/inflectional errors on content words	5	8
Errors on function words (n = 69)	32	46
TOTAL WORDS IN PASSAGE	125	

Fig. 4.3.1 Word length and reading speed : DP

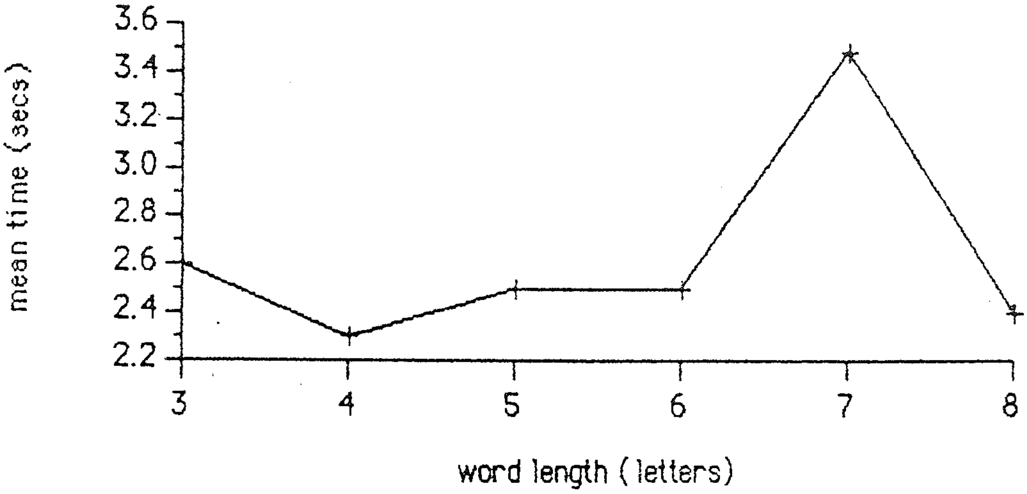


Fig. 4.3.2 Reading responses to words : DP

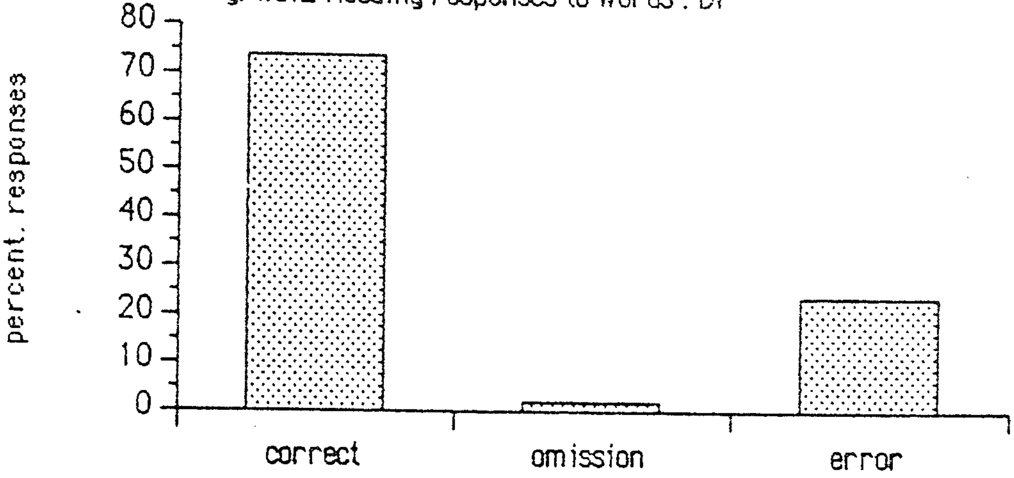


Fig. 4.3.3 Reading responses to nonwords : DP

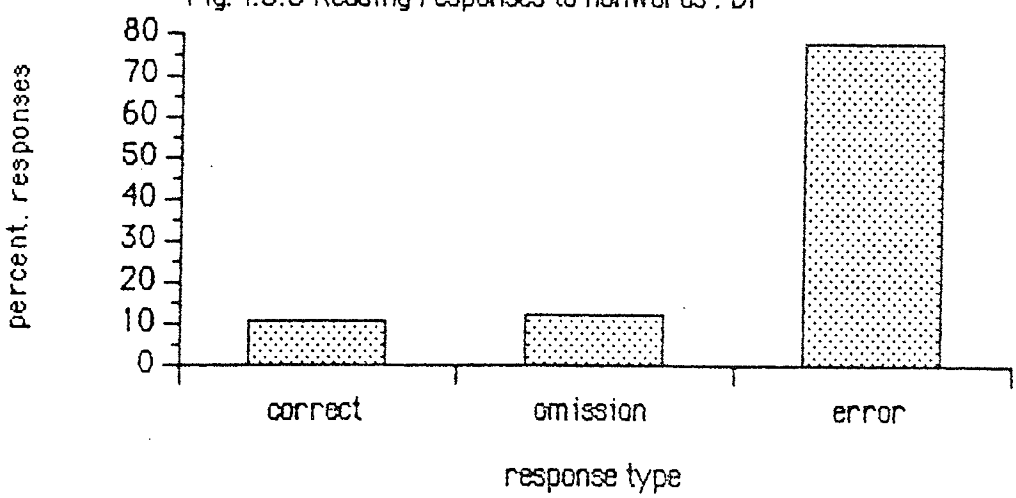


Fig. 4.3.4 Types of error response to words : DP

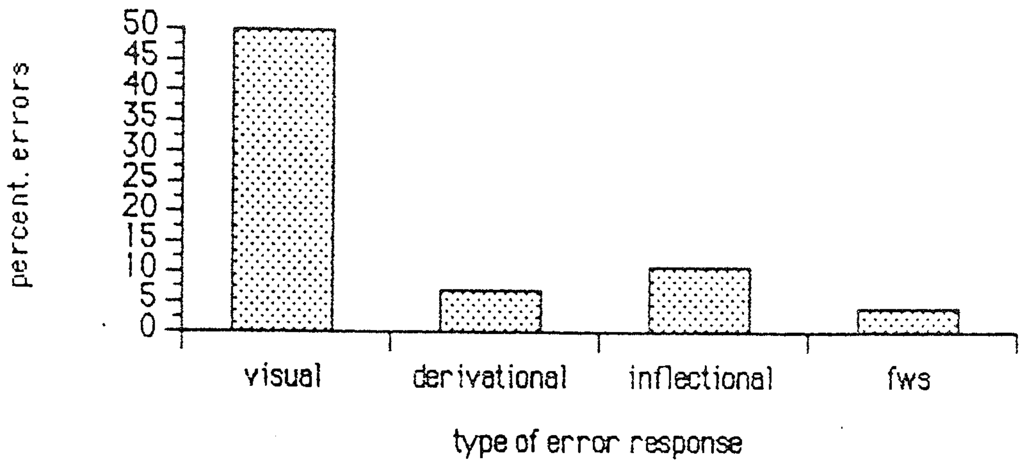
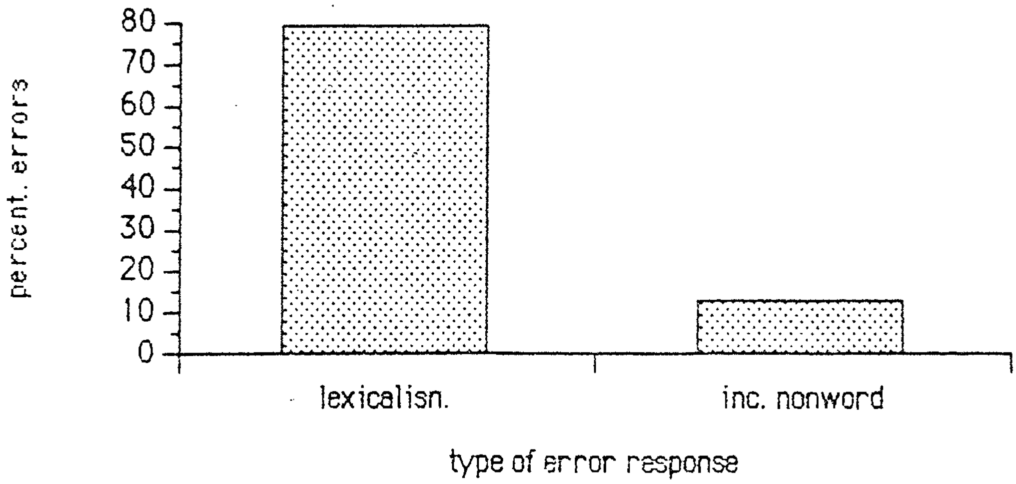


Fig. 4.3.5 Types of error response to nonwords : DP



4.3.6 Analysis of results

4.3.6.1 Reading at the single word level

A significant effect of the variable is observed in only two tests of word reading at the single-word level. DP is significantly better at reading unsuffixed than suffixed words in the Presence of Suffix I Test (X^2 (1df) = 7.2, $P<.01$). A significant effect of this variable is not observed in the Presence of Suffix II Test (X^2 (1df) = .06, $P>.05$). High-imageable words are read better than low-imageable words in the difficult Imageability Test (X^2 (1df) = 6.7, $P<.01$) but not in the standard Imageability Test Z = 0, $P>.05$). There is no effect of Part of Speech in the revised test (X^2 (3df) = 4.5*, $P>.05$) or the easy test (X^2 (3df) = 4*, $P>.05$), or of Regularity of Spelling (X^2 (1df) = 5, $P>.05$), Frequency (X^2 (1df) = 1.8, $P>.05$), or Word Length (Kendalls' S = -1, $P>.05$) on reading accuracy. Word length has no effect on reading speed (Kendalls' S = -1, $P>.05$). Lexical Decision performance on the easy test is almost perfect (Hit Rate = 1, False Alarm Rate = .04, d' = 4.07) but impaired on the difficult version of the test (Hit Rate = .8, False Alarm Rate = .3, d' = 1.36).

4.3.6.2 Comprehension Tests

There is no significant effect of imageability in the Synonym Matching task (X^2 (1df) = 3.2, $P>.05$) or the task requiring reading aloud of the stimuli used in this task (X^2 (1df) = 3.5, $P>.05$) although X^2 approaches significance in both cases. DP's score of 12/16 on the Semantic Probe Test is not significantly above chance (chance = 8 ± 4);

however she obtained full marks on the Comprehension of Functors Test.

4.3.6.3 Tests of nonword processing

DP's word reading is significantly better than her nonword reading on the Reading Aloud Easy Lexical Decision Test (X^2 (1df) = 46.2, $P<.001$) and the Words and Nonwords of Different Structure Test (X^2 (1df) = 30.7, $P<.001$). There is no significant effect of varying structure on nonword reading (X^2 (7df) = 5*, $P>.05$) or word reading (X^2 (3df) = 3.5*, $P>.05$). There is no significant effect of pseudohomophony (I: Z = .85, $P>.05$); II: Z = 1.2, $P>.05$), consistency (in the Consistency Test scores on consistent and inconsistent stimuli are equal) or the presence of an inconsistent letter (Z = .51, $P>.05$) on reading performance. There is no effect of type of nonword in either Reading by Analogy Test (I: Z = 0, $P>.05$); II: Z = 0, $P>.05$). There is no effect of providing a colour cue on the Nonwords Synthesised From Words Test (Z = 1, $P>.05$) and words are not blended significantly better than nonwords on the Sound Blending I Test (X^2 (1df) = 1.2, $P>.05$). DP obtained a significantly higher score on the Segmentable Words Test when stimuli were presented in the visual mode (X^2 (1df) = 14.7, $P<.001$). The scores on all Silent Tests of Phonology yield relatively low values of d', the lowest value being on the nonword version of the first test (I: Nonword version, Hit Rate = .3, False Alarm Rate = .4, d' = -.27; Regular Word Version, Hit Rate = .8, False Alarm Rate = .6, d' = 2.58; Irregular word version, Hit Rate = .7, False Alarm Rate = .6, d' = .27; II, Hit Rate = .9, False Alarm Rate = .5, d' = 1.28.

4.3.6.4 Tests of Repetition Ability

There is no significant difference between performance on words and nonwords in the Pseudohomophony Test I Test ($Z = 0$, $P>.05$) or the Easy Lexical Decision Test ($Z = .51$, $P>.05$). There is no significant effect of type of nonword on repetition performance (X^2 (6df) = 11.2*, $P>.05$).

4.3.6.5 **Reading Errors: Words**

The highest proportion of errors (50%) are visually similar to the stimulus. Significantly more Visual than Derivational/Inflectional errors are made (X^2 (1df) = 27.4, $P<.001$). In the latter class of errors there is no significant difference between the number of errors which are derivational and the number which are inflectional (X^2 (1df) = 1.78, $P>.05$) although the latter category is numerically greater. Significantly more Function Word Substitutions are visually similar to the stimulus are visually dissimilar (X^2 (1df) = 5.4, $P<.05$).

4.3.6.6 **Reading Errors: Nonwords**

The majority of DP's error responses to nonwords are lexicalisations which account for 79% of errors. The number of lexicalisation errors is significantly greater than the number of errors which are incorrect nonwords (X^2 (1df) = 103.8, $P<.001$). The majority of lexicalisations (89%) are visually similar to the stimulus. The difference between the number of visually similar and the number of visually distinct lexicalisations is significant (X^2 (1df) = 102.5, $P<.001$).

4.3.6.7 Reading Errors: Text

The number of errors and omissions made on the stems of content words differs significantly from the number of errors and omissions made on function words in reading aloud the passage of text (X^2 (1df) = 7.3, $P < .01$).

4.3.7 Discussion of Reading Impairment

4.3.7.1 The lexical-semantic and direct routes

The evidence for the continued operation of these routes is not straightforward in the case of DP. The relevant aspects of performance are as follows. The first two observations suggest that the direct route is intact.

1. DP makes semantic errors in the confrontation object naming task and in written spelling to dictation. In the former task, semantic errors account for 87% of error responses, in the latter for between 5 and 13% of error responses. She makes no clear semantic errors in reading tasks; possible semantic errors are also visually similar to stimuli and the category "Visual or Semantic" accounts for only 2% of reading error responses. If semantic errors occurred only in written spelling and not in reading or naming a deficit at the point at which the semantic representation addresses entries in the graphemic word representation system might explain the

dissociation between the two modalities. Since semantic errors also occur in the confrontation object naming task in which the semantic representation addresses the oral word representation system, a similar explanation in terms of failure of semantic representations to access oral work representations cannot be maintained. The latter store is accessed in the reading task. The semantic system itself is thus implicated and since it is assumed that "the sole component (of the reading process) that does not fractionate ... is the semantic system" (Marshall and Newcombe, 1983) it must be concluded that the absence of semantic errors in reading tasks indicates that the direct route is operational.

2. There is no effect of Part of Speech in reading aloud single words, and, in particular no deficit on function words. This pattern is compatible with a functional direct route in a patient who is unable to use the phonological route for reading. By contrast there is a function word deficit in written spelling. The Function Word Substitutions which DP makes can be explained as a sub-class of visual errors if the direct route is assumed to be functional. This error category accounts for a very small proportion (4%) of DP's errors and only 1 Function Word Substitution (am → "and") is not visually similar to the stimulus. (In fact, there is visual closeness in this case although the strict conditions for visual errors are not met). A large proportion of visually dissimilar Function Word Substitutions would be difficult to explain in a patient who was able to use the

direct route.

It is interesting to note that although there is no function word deficit in reading at the single word level, significantly more errors are made in response to function than to the stems of content words in reading text. This pattern, which has been observed in other cases of phonological dyslexia, will be discussed in Chapter 5.

Other observations are more easily explained if it is assumed that DP is relying on the lexical-semantic route in the absence of the direct route, but can be given alternative explanations.

3. There is an effect of imageability in the Difficult Imageability Test with more high-imageable than low-imageable words being read correctly. There is, however, no imageability effect in the Easy Imageability Test. DP's pre-trauma reading vocabulary may not have included many of the items in the Difficult Tests. (Other Difficult Versions of tests were not given). It is possible that a reading vocabulary suited to reading magazine and newspaper articles and the occasional novel might tend to favour low-frequency, high-imageable rather than low-frequency, low-imageable words. Intuitively, it seems that the words "pianist", "blister", and "accordion" would be far more likely to crop up in a short story in a popular magazine than would the words "concept", "fallacy", and "criterion" even though these

words are of similar frequency according to the Thorndike-Lorge count. This statement is not borne out by examination of the "L" frequency count in Thorndike-Lorge which is taken from the Lorge Magazine Count. Items matched for frequency on the general count also match on the "L" count. However the original Lorge count is not referenced by Thorndike-Lorge and no listing of the range of magazines used in the count is provided so that the count could have included "The Listener" and "The Economist" as well as popular magazines like "The People's Friend". The possibility of an interaction between frequency and imageability has been suggested elsewhere. Data from HM, a developmental phonological dyslexic (Temple & Marshall, 1983) shows markedly poorer performance on words which are low on both imageability and frequency.

4. Performance on the synonym matching task is better than performance on the reading task which uses the same stimuli, although this difference does not reach significance. Nevertheless if there is a semantic impairment which leads to semantic errors in writing and naming tasks it might be expected that performance on reading aloud would be better than performance on synonym matching. It is possible, however, for the synonym matching task score to be augmented by chance, since the task requires the assignment of cards to one of two labelled piles, whereas the reading aloud score cannot be augmented by chance. Since the difference between scores on the two tasks is not significant the pattern of performance on the two tasks does not provide convincing

evidence that the direct route is not intact.

4.3.7.2 The Morphological Decomposition System

The weight of evidence supports the assumption that the direct route is intact in this patient. In cases where this route is shown to be functional, the pattern of reading errors becomes relevant to the question of the locus of the morphological decomposition system. The alternatives (discussed in Chapter One) are a) that the morphological decomposition system is located within the lexical-semantic route following visual word recognition (as in Fig. 1.5) or b) that the visual word recognition system is morpheme-based. The relevant aspects of reading behaviour with respect to this issue are the occurrence of derivational and inflectional errors and the effect of the presence of a suffix on reading performance. As noted in earlier discussion, lexical decision performance on affixed words provides less reliable evidence since there may be semantic involvement in the lexical decision task.

Unfortunately, interpretation of DP's performance on the tests which investigate performance on suffixed words, like the interpretation of her performance on tests relevant to the operation of the direct route is not straightforward. She showed a strong effect of the presence of a suffix in the Presence of Suffix I Test, but no effect at all in the Presence of Suffix II Test. As explained in Chapter 3, the former test is composed of suffixed and non-suffixed words matched for frequency of the root morpheme but not for word length, suffixed items being longer than non-suffixed. In the second test, items are matched for word length and frequency of the inflected form. If however frequency of the root morpheme is the important variable then non-suffixed words may be of lower frequency than suffixed words in this test. DP shows no effect of word length or of frequency in the test investigating these variables. It is however possible, that the low-frequency non-suffixed words in the second test, like the difficult low-imageable words, may not have formed part of DP's pre-trauma reading vocabulary. In this case, any lowering of performance on suffixed words (of which DP read only 50% correctly) would be obscured by her poor performance on the non-suffixed matches. In the absence of an effect of word length (there was no significant difference between DP's success rate on words ranging from 3 to 8 letters in length) the effect of the presence of a suffix in the first test would appear to be genuine.

The next question relates to whether the derivational and inflectional errors made by DP are indeed genuine subclasses of errors or are categories of visual error. This issue is discussed in Chapter 2 (Section 2.1.5). The effect of the presence of a suffix on performance in itself suggests that errors are genuinely inflectional/derivational. The highest proportion (58%) of errors on suffixed words in Tests I and II are errors involving substitution or deletion of the affix and 46% of all derivational and inflectional error responses occurred in response to affixed stimuli. Inflectional and derivational errors account for a relatively small proportion of errors in DP's error corpus (11% and 7% respectively) but do appear to be genuine classes of error. There is, however, no significant difference between the number of inflectional and the number of derivational errors although the former category is numerically greater, and the tendency is for the correct part of speech to be retained in the error response. DP's pattern of reading errors provides some evidence for a morpheme-based visual word recognition system since the operation of the direct route yields derivational and inflectional errors and is affected by the presence of a suffix. However, since the evidence for the operation of the direct route and for the effect of the presence of a suffix is not unequivocal it cannot be regarded as conclusive evidence for a morpheme-based word recognition system. DP's errors on the Inappropriately Suffixed Nonwords Test are compatible with a morpheme-based visual word recognition system, but, in the light of the doubt regarding her ability to use the direct route, are subject to an alternative explanation. These errors are discussed in relation to the errors made by TW on this test (see Case Report III, Section 4.4.7.2).

4.3.7.3 The Nonword Reading Impairment

4.3.7.3.1 General comments

DP read very few nonwords correctly and her performance on the Reading Nonwords of Different Structure Test shows no significant effect of type of nonword. In no subtest did she read more than 2 nonwords correctly. Types of error response are also similar across all stimulus types. In each subtest the majority (50%-90%) of error responses are lexicalisations, remaining reponses being incorrect nonwords or omissions. Repetition of the stimuli in this test was good, ranging from 70-100% correct, and there is no significant difference between performance on words and nonwords in repetition tasks. Performance on Silent Test of Phonology is poor in word and nonword versions of the test and particularly poor in the nonword version in which d' is<zero. Thus DP's difficulty in reading aloud nonwords is not due to difficulty in articulating unfamiliar speech segments.

The abstract letter recognition system is not severely impaired as evidenced by a score of 97% correct on the Cross Case Letter Matching Task.

Tests of the operation of subsystems within the phonological route in tasks which do not require reading of nonwords indicate that the Blending and Resegmentation Systems are impaired but not entirely non-functional.

4.3.7.3.2 The Phoneme Allocation System

There is no evidence that the Phoneme Allocation system is operational. Only 4 out of 24 (17%) letter sounds were given in response to visually-presented letters. The few error responses produced which are incorret nonwords (13% of total errors on nonwords) are mainly classified as Gross/Multiple errors of grapheme-morpheme conversion and may share no graphemes/phonemes with the correct response (e.g. naud -> / ʃun/) or share only a single grapheme (e.g. lepwerd -> /l ɩŋ /).

4.3.7.3.3. The Resegmentation System

DP is able to segment words into component word units efficiently (90% correct on the Visual Segmentable Words Test). This task is not performed via phonological segmentation since DP's score was significantly lower on the auditory version of this task (43% correct). In the segmentation tasks administered by Patterson and Marcel (see Chapter 1, Note 3) DP was able to underline common letters in pairs of words (90% correct). She was less efficient in their second orthographic task involving the identification of one or two letters in a letter string which, when inserted into a gap in a second letter-string make it a word. She was much more competent in this task when 2 letters which formed a grapheme were involved (76% correct) than when 2 letters did not form a grapheme (25% correct). I shall not here discuss Patterson and Marcel's interpretation of the results (their paper is in preparation) but note that DP's performance on these tasks indicates some impairment of the Resegmentation System.

4.3.7.3.4 The Blender

DP is able to blend auditorily-presented phonemes to form words (71% correct) and, more importantly, since this ability may be susceptible of alternative explanation (see Chapter 3, Section 3.1.5.8) to form nonwords (50% and 51% correct). She also shows a limited ability to blend words to form nonwords (60% correct on the Nonwords synthesised from Word Test with colour cues). The scores indicate that the subsystem is operational though somewhat impaired.

4.3.7.3.5 Concluding comments

As noted in the introduction to these case reports, the high proportion of lexicalisation errors (79% of DP's errors are lexicalisations) is interpreted as indicating reliance on a lexical route for nonword as well as word reading. The phonological route is, on this account, almost totally non-functional. A lesion in one of the pathways within the phonological route is suggested by the almost total lack of output from this route. The site of this lesion is difficult to establish on the basis of results from tasks which do not require reading aloud of nonwords. Performance on resegmentation tasks, in which the visual stimulus does access the subsystem suggests that the lesion is not located in the pathway from the abstract letter recognition system to the resegmentation system. More precise specification of the site of such a lesion is not possible on the basis of the data available.

4.3.8 Summary

DA presents with a phonological dyslexia in which the direct route appears to be intact; there is however some contradictory evidence regarding the operation of this route. Nonword reading is very poor and it is not possible to establish the precise locus of impairment within the phonological route. However, there is evidence that the lesion is not in the pathway from the abstract letter recognition system to the resegmentation system and that there is some residual activity of the resegmentation system and the blender.

Notes for Case Report II

1 A complete list of DP's Bizarre errors is provided below:

Nonword

fate	-	Attert
hint	-	direst
mind	-	ittent
folly	-	seiph
event	-	Everbra
method	-	Teip
origin	-	Oriephanie
average	-	affiect
democracy	-	redam
gift	-	monkest
office	-	moise
engine	-	Geiqu
journal	-	Gursere
musician	-	dissinam
reason	-	remi
enter	-	der
hotel	-	C.Boisterm
all	-	rine
sign	-	sieting
issue	-	hite
sword	-	waset
used	-	hor
hog	-	ergh
rot	-	sotten (distortion of rotten?)
bet	-	herim
lump	-	giegh
ample	-	hiven
intend	-	permine
publish	-	grefing
complete	-	quiston
division	-	delects
fern	-	turm
lint	-	ottermt
valley	-	rame
cactus	-	diem
village	-	irette
factory	-	gramb
apricot	-	grarint
moist	-	titt
stale	-	shillend
silent	-	trimped
porous	-	temint
natural	-	cament
fragile	-	enint
oust	-	hurm
carry	-	tirent
relax	-	itent
evade	-	tillant
elope	-	didrent
arrive	-	gimill

defend	-	dirrent
punish	-	grent
meddle	-	tralled
abolish	-	pollint
applaud	-	ittent
nor	-	cu
eye	-	tittin
see	-	singn
due	-	dewst
old	-	rown, (won)
buy	-	ri
for	-	cound

<u>Word</u>

floor	-	move
food	-	To
idea	-	siting
topic	-	Topside
landscape	-	under
let	-	dear
older	-	ginger
boxes	-	now
tan	-	strand
number	-	nest
figure	-	if
liberty	-	boding
large	-	Brought
shallow	-	came
send	-	soar
pamper	-	tram
soggy	-	sam
sparrow	-	pall
wall	-	would
why	-	yen
once	-	sit
ask	-	sham
but	-	heir
old	-	(rown) won
you	-	row
sure	-	sword

2 The semantic errors made by DP on the Boston Naming Test are as follows:

pencil → "pen; octopus → "crab" (following stimulus cue); racquet → "bat and ball": seahorse → "octopus"; wreath → "holly (following stimulus cue; rhinocerous → "camel"; cactus → "tree": knocker → "bell" (following stimulus cue); pelican → "duck", no, geese"; accordian → "banjo"; wheelchair → "chair"; canoe → "boat"; noose → "rope".

DP indicated that she recognized the correct name in each case.

Case Report III: TW

4.4.1 Neurological Background

TW is a 38-year old right-handed man who sustained a CVA in February, 1979. He was admitted to the Midland Centre for Neurosurgery and Neurology where an area of subarachnoid haemorrhage was identified and a mid-cerebral aneurisectomy was performed. He was returned to Selly Oak Hospital with severe aphasia, an oral apraxia and a dense right hemiparesis. He suffered a number of epileptic fits which have now ceased. His aphasia persists, expressive speech being severely limited, although functional communication is achieved. The hemiparesis has resolved and he is able to write with his preferred right hand.

4.4.2 Education and Occupational Background

TW received 9 years schooling (in Dublin where he was born and brought up). Prior to his CVA he was employed as a bus driver in the West Midlands. He read a great deal, especially newspapers (he was and is very interested in discussing current affairs) and novels, his preference being for Westerns. He had no difficulty with writing and reports that he wrote frequent letters to his family and was required to write reports at work.

4.4.3 Aphasia and Dysgraphia

Immediately post trauma TW presented with a severe comprehension deficit affecting all levels except simple word-identification and was severely limited in his expressive language abilities in which perseverative tendencies and the production of neologisms were noted. A mild oral apraxia and a constructional apraxia in writing were present. His comprehension, though still impaired, is now much improved. He scored at or above the 50th percentile on all auditory and reading comprehension subtests of the BDAE, his lowest score (10/15) being on the Commands Subtest and his highest (67/72) on Word Discrimination. He claims to be able to follow the gist of newspaper articles although he is usually unable to read all the words individually. Neologisms are now absent in spontaneous speech and there is little apraxic involvement. Nevertheless expressive speech is still limited. Melodic line is limited to short phrases and stereotypes and speech tends to be telegrammatic with minimal use of grammatical constructions, phrase length rarely exeeding 5 words. The following is an example of spontaneous speech elicited by a request to talk about his job as a bus driver.

"Er well, er, sixty-nine, sixty-nine, when I went on the buses. Er, don't know really ... it's.... (Examiner: What was the day like? Tell me about a typical day at work.) Er, well, six-thirty, ten, a break, eleven-thirty a break, er five, five, ten, it's er ... it's a break you know, you know sausage and that you know, er, not a break it's, er dinner, dinner. Yeah, er then about six-thirty, er it's .... (Examiner: Was that when you finished again?) Yeah, six-thirty and then eleven you know - it depends. (Examiner: Oh, you worked shifts, did you?). Exactly, yes. See, um, let's see, fifteen hundred hours and then, let's see, about eleven, twelve you know, and then the breaks, no not the breaks, no."

Scores on all Naming Subtests of the BDAE placed TW between the 70th and 80th percentile. Scores on Repetition Subtests placed him between the 60th and 70th percentiles. There is no impairment of repetition at the single word level, TW's only failure in the Repetition of Words Subtest being on "Methodist Episcopal". A copy of the BDAE Subtest Summary Profile is provided in Appendix I.

TW's written spelling abilities are very severely impaired. He wrote only 2/28 words correctly and no nonwords. Rate of omissions was 50%. Error responses involved repeated attempts at words and performance on spelling tasks was always slow and effortful.

4.4.4 **Neuropsychological Baseline Tests**

TW scored 17/60 in the Boston Naming Test. He obtained a Memory Quotient of 70 on the Wechsler Memory Scale. He obtained relatively high scores on the Logical Memory Subtest (performance on the first passage being much better than on the second when perseverations from the first passage were evident) and the Paired-Associate Learning Subtest. Performance on the Mental Control Subtest was very poor and TW obtained a zero score. Digit span is 5 forward and 0 backward. A score of 21/36 on the Token Test indicates a moderate impairment of comprehension. TW obtained an I.Q. equivalent of 101 on the Spoken and 94 on the Written Version of the PPVT.

4.4.5 Reading and Repetitition Tests

The results of reading and repetition tests are shown in Tables 4.4.1 to 4.4.9. A transcript of TW's reading of the passage of text is provided in Appendix II. Error types are shown in Tables 4.4.10 to 4.4.12. Fig. 4.4.1 shows the effect of word length on reading speed. Figs. 4.4.2 to 4.4.5 show graphically the proportions of different types of reading responses to words and nonwords (major error categories only).

Table 4.4.1 READING AT THE SINGLE LETTER LEVEL

Test		Number Correct	Percentage Correct
Single letter naming	n = 26	23	88
Single letter sounding	n = 24	0	0
Single letters from a string	n = 20	14	70
Cross-case letter matching	n = 58	44	76

Table 4.4.2 READING AT THE SINGLE WORD LEVEL

Test	Number Correct	Percentage Correct	Significant effect of Variable
Easy lexical decision n = 50	45	90	
Difficult lexical decision n = 40	27	68	
Imageability (standard)			
High Imageable n = 20	20	100	-
Low Imageable n = 20	18	90	
Imageability (difficult)			
High Imageable n = 20	11	55	-
Low Imageable n = 20	8	40	
Part of speech (easy)			
Noun n = 20	19	95	-
Verb n = 20	18	90	
Adjective n = 20	19	95	
Function word n = 20	19	95	
Part of Speech (difficult)			
Noun n = 20	15	75	+
Verb n = 20	11	55	
Adjective n = 20	13	65	
Function word n = 20	6	30	
Part of speech (revised)			
Noun n = 25	24	96	-
Verb n = 23	19	83	
Adjective n = 25	21	84	
Function word n = 37	29	78	
Regularity of spelling (standard)			
Regular n = 39	35	90	-
Irregular n = 39	31	79	
Regularity of spelling (difficulty)			
Regular n = 20	14	70	-
Irregular N = 20	12	60	

Table 4.4.2 READING AT THE SINGLE WORD LEVEL (continued)

Frequency			
High Frequency n = 23	23	100	-
Low Frequency n = 23	21	91	
Word length			
3-letter n = 10	10	100	-
4-letter n = 10	8	80	
5-letter n = 10	9	90	
6-letter n = 10	8	80	
7-letter n = 10	10	100	
8-letter n = 10	10	100	
Presence of Suffix I			
Suffixed n = 30	26	87	-
Unsuffixed n = 30	29	97	
Presence of Suffix II			
Suffixed n = 28	18	64	-
Unsuffixed n = 28	18	64	

Table 4.4.3 COMPREHENSION TESTS

Test	Number correct	Percentage correct
Synonym matching		
High Imageable n = 38	21	55
Low Imageable n = 38	26	68
Semantic Probe n = 16	12	75
Comprehension of functors n = 18	13	72

Table 4.4.4 TEST OF MORPHOLOGICAL KNOWLEDGE

Test	Number correct	Percentage correct
Single word test n = 32	17	53

Table 4.4.5 TESTS OF NONWORD PROCESSING

Test	Number correct	Percentage correct	Significant effect of Variable
Reading aloud			
Easy Lexical Decision			
Words n = 25	25	100	+
Nonwords n = 25	1	4	
Nonwords with inconsistent letters			
With inconsistent letter n = 36	1	3	-
Without inconsistent letter n= 36	0	0	
Nonwords synthesised from words			
with colour cue n = 10	4	40	-
without colour cue n = 10	1	10	
Segmentable words			
Visual mode n = 30	28	93	+
Auditory mode n = 30	17	57	
Hidden words n = 20	12	60	+
Sound Blending I			
Words n = 24	10	42	+
Nonwords n = 8	0	0	
Sound Blending II n = 35	4	11	
Consistent and Inconsistent nonwords			
With consistent segment n = 15	2	13	-
With inconsistent segment n = 15	3	20	
Reading by analogy I:			
Deletion			
Type A nonwords n = 15	0	0	-
Type B nonwords n = 19	0	0	
Reading by analogy II:			
Substitution			
Type A nonwords n = 14	4	29	-
Type B nonwords n = 14	2	14	
Pseudohomophony I			
Pseudohomophones n = 15	4	27	-
Non-pseudohomophones n = 15	2	13	
Pseudohomophony II			
Pseudohomophones n = 10	2	20	-
Non-pseudohomophones n = 10	0	0	

Table 4.4.5 TESTS OF NONWORD PROCESSING (continued)

Test		Number correct	Percentage correct	Significant effect of Variable
Reading aloud difficult lexical decision				
Words	n = 20	3	15	
Nonwords	n = 20	0	0	
Inappropriately suffixed nonwords	n = 25	3	15	
Affixes in isolation	n = 10	1	10	

Table 4.4.6 READING ALOUD NONWORDS OF DIFFERENT STRUCTURE

Type	Example	Number correct	Percentage correct
A	tad	0	10
B	ank	1	10
C	ead	2	20
D	eth	1	10
E	tood	1	10
F	dack	0	0
G	dunt	0	0
H	afe	1	10

n = 10 in each list

Table 4.4.7 READING ALOUD WORDS AND NONWORDS OF DIFFERENT STRUCTURE

Type	Percentage of words correct	Percentage of nonwords correct
A	80	10
E	90	10
F	80	0
G	80	0

n = 10 in each list

Table 4.4.8 SILENT TESTS OF PHONOLOGY

Test	Number correct	Percentage correct
Silent test of phonology I		
Nonword n = 50	27	54
Regular word n = 50	22	44
Irregular word n = 50	24	48
Silent test of phonology II n = 40	26	65
Silent test of phonology II n = 30	14	47

Table 4.4.9 TESTS OF REPETITION ABILITY

Test	Number correct	Percentage correct
Pseudohomophony I		
Words n = 15	14	93
Nonwords n = 15	14	93
Easy lexical decision		
Words n = 25	25	100
Nonwords n = 25	23	92
Nonwords of different structure		
Type A n = 10	9	90
Type B n = 10	8	80
Type C n = 10	9	90
Type D n = 10	10	100
Type E n = 10	10	100
Type F n = 10	10	100
Type G n = 10	9	90

Table 4.4.10 READING ERRORS - WORDS

		Number of errors	Percentage of errors
Visual		104	53
Sharing initial letter(s) with stimulus	33		
Sharing init. & fin. letter(s) with stimulus	46		
Sharing final letter(s) with stimulus	18		
Sharing medial letter(s) with stimulus	1		
Sharing letter(s) not in corresponding psns.	6		
Derivational		18	9
Derivational or Inflectional (ing)		3	2
Inflectional		12	6
Nouns	7		
Verbs	4		
Adjectives	1		
Function Word Substitutions		4	2
Visually similar	3		
Visually dissimilar	1		
Semantic		1	1
Other		54	28
Completion	2		
Possible visual	2		
Partial regularisation	1		
Phonemic paraphasias	8		
Complex word substitutions	22		
Visual and articulatory	1		
Substitution, omission or deletion of word segments	13		
Unclassified	5		
TOTAL ERRORS		196	
Words misread		159	17
Omissions		16	2
Words read correctly		785	82
TOTAL PRESENTED		960	

Additional errors due to multiple attempts 20

Table 4.4.11 READING ERRORS NONWORDS

		Number of errors	Percentage of errors
Lexicalisations		224	97
Visually similar to stimulus 209			
sharing initial letter(s) with stimulus	69		
sharing init. & fin.letter(s) with stimulus	61		
sharing final letter(s) with stimulus	70		
sharing letters not in corresponding posns.	9		
Visually distinct from stimulus 15			
sharing initial letter(s) with stimulus	7		
sharing letter(s) not in corresponding posns.	5		
sharing phoneme(s) but not letters with stimulus	3		
Incorrect nonwords		4	2
gross errors of grapheme-phoneme conversion	2		
omission/misconversion of single grapheme/phoneme	2		
Other		3	1
Sementation 2			
Unclassified 2			
TOTAL ERRORS		231	
Nonwords misread		223	81
Omissions		32	12
Nonwords read correctly		22	8
TOTAL PRESENTED		277	

Errors corrected 1
Additional errors due to multiple responses 7

Table 4.4.12 TEXT READING ERRORS

		Number of errors	Percentage of errors
Errors on stem of content words (n = 56)		2	4
Derivational/inflectional errors on content words		6	11
Errors on function words (n = 69)	29	42	
TOTAL WORDS IN PASSAGE		125	

Fig.4.4.1 Word length and reading speed : TW

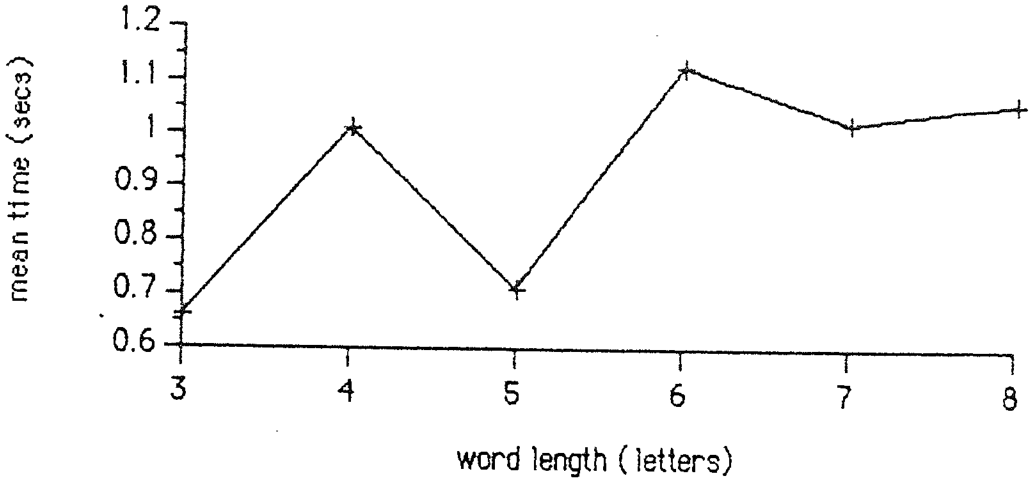


Fig.4.4 2 Reading responses to words : TW

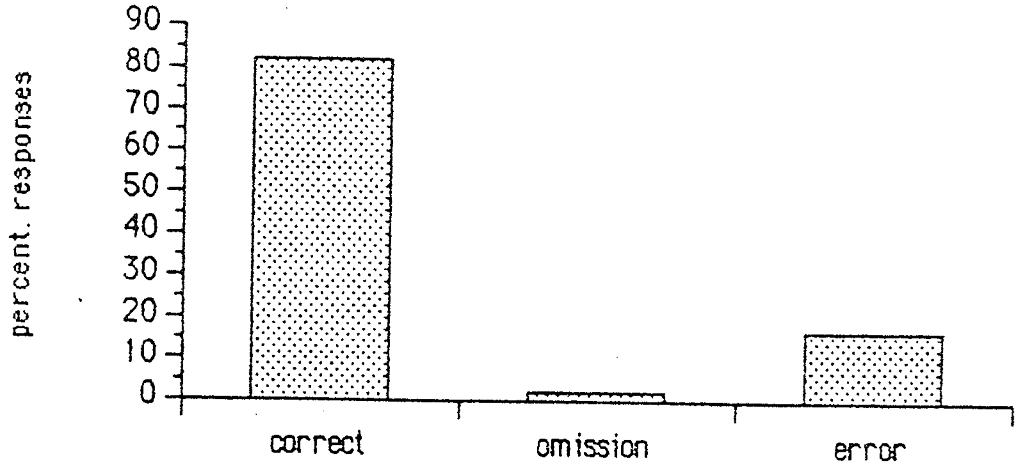


Fig.4.4.3 Reading responses to nonwords : TW

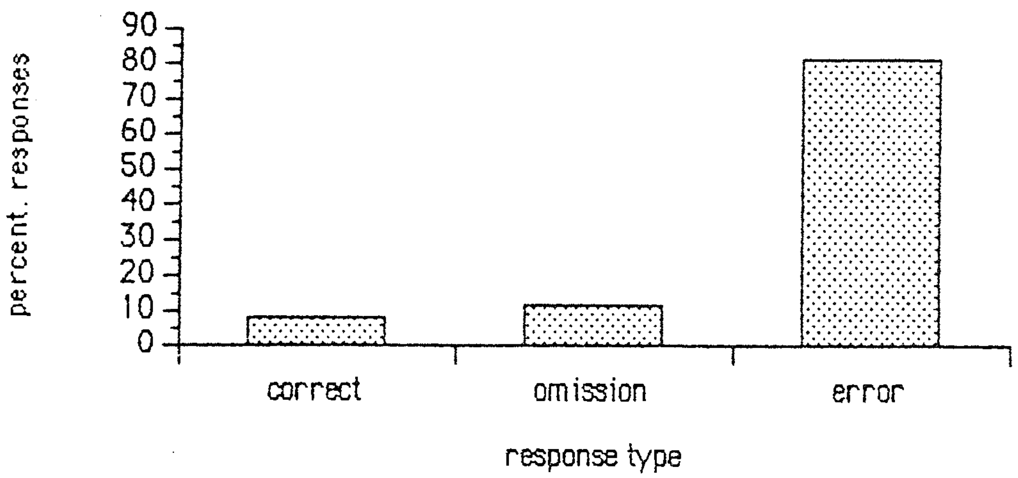


Fig. 4.4.4 Types of error response to words : TW

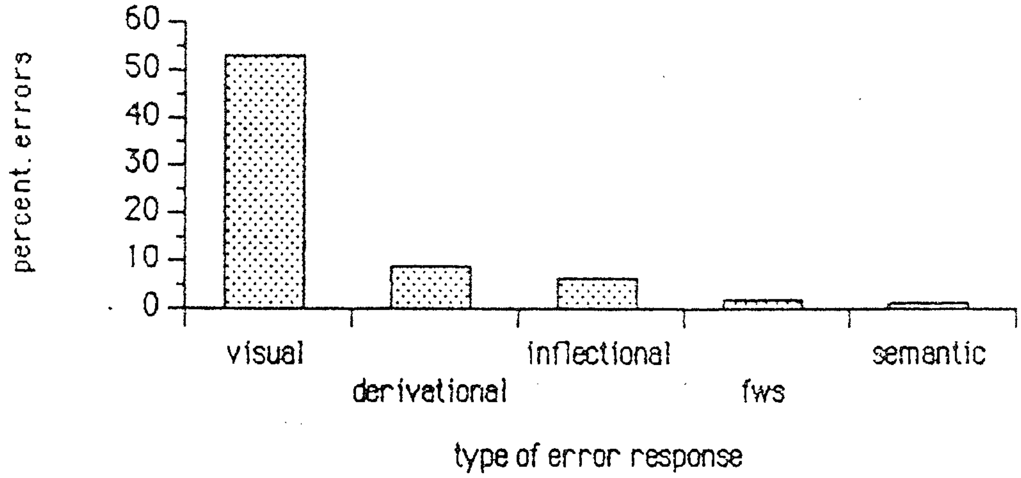
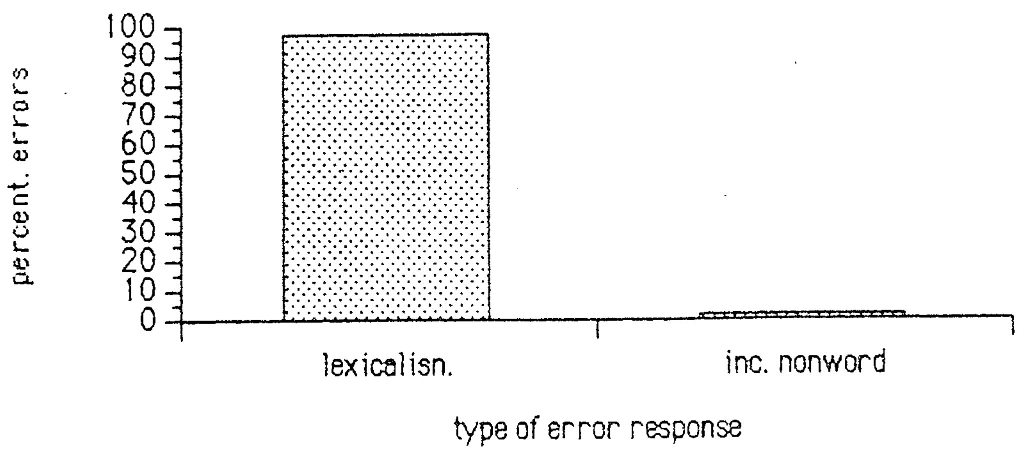


Fig. 4.4.5 Types of error response to nonwords : TW



4.4.6 Analysis of Test Results

4.4.6.1 Reading at the single word level

There is no significant effect on performance of varying the Imageability (Standard Test: Z = .72, P>.05; Difficult Test: X^2 (1df) = .9, P>.05), Regularity of Spelling (Easy Test: X^2 (1df) = 1.6, P> .05; Difficult Test: X^2 (1df) = .44, P>.05), Frequency (Z = .72, P> .05) or Length (Number Correct: Kendall's S = -3, P>.05; Reading Speed Kendall's S = +9, P>.05) of stimuli. There is no effect of the Presence of a Suffix (Presence of Suffix I = X^2 (1df) = 2, P>.05; Presence of Suffix II: identical scores on both stimulus types). There is no effect of Part of Speech in the Easy Test ((X^2 (3df) = .68*, P>.05) or the Revised Test (X^2 (3df) = 4.9*, P>.05). In the Difficult Part of Speech Test there is a significant effect of the variable (X^2 (3df) = 9.1, P<.05), Function Words being read less well than other parts of speech.

4.4.6.2 Tests of Comprehension and Morphological Knowledge

There is no effect of Imageability in the Synonym Matching Test (X^2 (1df) = 1.4, P>.05). TW's score on reading aloud words in the Synonym Matching Test is significantly higher than his score on the matching task (X^2 (1df) = 21.7, P<.001). The score on the Semantic Probe Test is not significantly above chance (chance = 8$\pm$4). The score on reading aloud words in the Semantic Probe Test is significantly higher than the score on the comprehension task. The score on the Comprehension of Functors Test is significantly above chance (chance =

9 ± 3). In the Single Word Test of Morphological Knowledge Hit Rate = .6, False Alarm Rate = .6, d' = 0.

4.4.6.3 **Test of Nonword Processing**

Significantly more words than nonwords were read in reading aloud stimuli in the Easy Lexical Decision Test (X^2 (1df) = 46.2, $P<.001$) and in the Structured Words and Nonwords Test (X^2 (1df) = 48.8, $P<.001$). Very few nonwords in the Structured Nonwords Test were read and there is no significant effect of type of nonword (X^2 (7df) = 3.5*, $P>.05$). In the Nonwords with Inconsistent Letters Test only 1 nonword was read correctly and a X^2 analysis was not performed. Analysis was not performed on the Pseudohomophony II Test because of low scores. There is no significant effect of pseudohomophony in the Pseudohomophony I Test ($Z = .45$, $P>.05$) or of consistency in the Consistent and Inconsistent Nonwords Test ($Z = 0$, $P>.05$). Only 3 words and no nonwords were read correctly in the Reading Aloud Difficult Lexical Decision Test, there being no significant effect of word/nonword status ($Z = 1.2$, $P>.05$). In the Reading by Analogy II Test there is no significant effect of type of nonword ($Z = .45$, $P>.05$). No nonwords were read in the Analogy I Test. There is no significant effect of the presence of the colour cue in the Nonwords Synthesised from Words Test (X^2 (1df) = 2.4, $P>.05$). In the Sound Blending I Test the score on words is significantly higher than the score on nonwords ($Z = 1.73$, $P<.05$). The score in the Segmentable Words Test presented in the visual mode is significantly higher than the score when stimuli were presented in the auditory mode (X^2 (1df) = 10.8, $P<.001$). Performance was poor with d' values of zero on all versions of the Silent Tests of Phonology I (Nonword: Hit Rate = .6, False Alarm Rate = .6, d' = 0; Regular Word: Hit Rate = .4, False Alarm Rate = .6, d' =-.51;Irregular Word, Hit Rate = .5, False Alarm Rate = .5, d' = 0). In the Silent Test of Phonology II, Hit Rate = .8, False Alarm Rate = .6, d' = .58. In the Silent Test of Phonology III, Hit Rate = .3, False Alarm Rate = .3, d' = 0.

4.4.6.4 Tests of Repetition Ability

There is no significant difference between scores on repetition of words and scores on repetition of nonwords in the Pseudohomophony I Test (in which scores on words and nonwords are identical) and the Easy Lexical Decision Test ($Z = .71$, $P > .05$). In the task requiring repetition of stimuli in the Nonwords of Different Structure Test scores on different nonword types are very close and low expected values make X^2 analysis inappropriate.

4.4.6.5 Reading Errors: Words

The highest proportion of errors (53%) are Visual; this error category contains significantly more responses than the total of the Derivational and Inflectional categories which, when combined, account for 17% of errors and represent the next largest category (X^2 (1df) = 36.8, $P < .001$). There is no significant difference between the number of Derivational and the number of Inflectional errors (X^2 (1df) = 1.2, $P > .05$).

4.4.6.6 Reading Errors: Nonwords

The majority (97%) of TW's errors are Lexicalisations. There are significantly more Lexicalisations than Incorrect Nonword errors (X^2 (1df) = 212.2, $P<.0001$). Significantly more Lexicalisation errors are visually similar to the stimulus than are visually distinct (X^2 (1df) = 168, $P<.001$).

4.4.6.7 Reading Errors: Text

Significantly fewer errors are made on the Stems of Content Words than are made on Function Words (X^2 (1df) = 24.6, $P<.001$).

4.4.7 Discussion of Reading Impairment

4.4.7.1 Reliance on the direct route for reading aloud

There is evidence of some impairment of comprehension in this case. TW's score on the Semantic Probe Test is not significantly above chance and his overall score of 62% correct on the Synonym Matching Task is significantly poorer than his score on reading aloud the items in the latter test (93% correct). The same is true of TW's performance in the Semantic Probe Test - reading aloud of test items is significantly better than performance on the comprehension task (96% correct and 75% correct respectively). Since TW read only 8% of simple nonwords presented to him, performance falling to zero when longer nonwords from the difficult lexical decision test were presented for reading aloud, it is implausible that TW is able to use the phonological route in the reading aloud task[1], especially when longer items like detection and sarcasm are read aloud correctly but incorrectly matched.

It is possible that the matching task, requiring comparison of two lexical entries, is intrinsically more difficult than a reading task. In this case one would expect a trend towards better performance on the reading task by all patients. No such trend is observable. DP (Case Report II) for example, performed significantly better on the matching task; in this case there is clearly no deficit on the matching as compared with the reading task. Similarly DA (Case Report I) was able to perform the matching but not the reading task.

The observed dissociation in TW's performance between reading and comprehension tasks is, therefore, strong evidence that the direct route is operational and that TW relies on this route when reading aloud single words.

The absence of an Imageability effect is compatible with reliance on this route, although there is no such effect in the comprehension task which is concerned with this variable (compare JS, Case Report V) so that the semantic deficit clearly does not take the form of selective impairment of low-imageable words. The absence of a Part of Speech effect when reading words in isolation (although not in text reading when a Function Word deficit is observed) is also compatible with reliance on this route. The sole piece of contradictory evidence is the poor performance on Function Words in the Difficult Part of Speech Test. The function words in this test are matched for length and frequency with the items representing other parts of speech. As mentioned in discussing the performance of DP (Case Report II) however, when Difficult Tests are presented to patients who may have a limited pre-trauma reading vocabulary, the possibility arises of certain classes of items not having been represented in the pre-trauma reading systems.

TW's strategy when presented with these difficult function words (some of which, for example howsoever and heretofore are most likely to be found within legal documents) is not clear. Although the majority of errors on these words are classified as Complex Function Word substitutions because they appear to involve segmentation into smaller function word units, a number of which are then confused with other function words, many of these errors may in fact be perseverative in origin. Ten out of the 22 errors (including multiple responses) in his category include the word "which", while the word "whatsoever" was produced 3 times as an error response. Apart from this error category, only 4 function word substitutions (2%) occur in the whole error corpus; 3 of these are visually similar. Such substitutions are not characteristic of TW's single word reading. The account of this apparent Part of Speech effect as resulting from the nature of the pre-trauma lexicon is plausible though not entirely satisfactory. However, a true function word deficit should surely have shown itself in all 3 Part of Speech Tests, yet differences in performance on the different types of stimuli in the Easy and Revised Tests do not approach significance.

One further aspect of TW's reading performance which is compatible with reliance on the direct route is his poor performance on both reading and making word judgements on the Difficult Lexical Decision Task. There are patients who are able to perform lexical decision tasks even when reading aloud of the stimuli is impaired (for example, PW, Morton and Patterson, 1980b, and CB, Case Report IV, this volume). These patients may be unable to access output phonology by means of a semantic representation or may be unable to access semantics by means of a visual word representation. It is assumed that their performance reveals that there is an entry for each word recognised as a word in the visual word representation system. If the pathway from visual word representation system to oral word representation system is unimpaired, any word recognised as a word should also be able to be pronounced. TW read aloud correctly only 3 of the items in his test (all 3 had previously been recognised as words) and his performance on the lexical decision task was very poor, d' being zero. Thus there is no dissociation between performance on the two types of task. In the Easy Lexical Decision Test in which all words were recognised as words (TW's few errors being due to acceptance of nonwords as words), all words were also read aloud correctly.

The highest proportion (53%) of TW's reading errors are visual and can be explained in terms of difficulty in accessing certain visual word representations or in selecting the correct match from a range of activated representations (see Chapter 2).

4.4.7.2 The Morphological Decomposition System

As the direct route is operational in this patient, the presence or absence of derivational and inflectional errors is relevant to the issue of whether the visual word recognition is morpheme-based or whether a morphological decomposition system is located within the lexical semantic route (see Chapter 1 for discussion). TW made 18 (9%) errors classified as derivational and 12 (6%) classified as inflectional. A further 3 (2%) containing the affix ing may be derivational or inflectional. Is there any certainty that these are "true" derivational or inflectional errors or are such errors a sub-class of visual errors? If TW's errors are truly derivational/inflectional, this is evidence for a morpheme-based visual word representation system. In fact, these error categories are equivocal in this case. Firstly, TW is not sensitive to the presence of a suffix in reading single words. On the other hand his rate of derivational/inflectional errors increases on suffixed words, accounting for 30% of errors on these words, while the overall proportion of this error type is much lower, accounting for only 17% of total errors. However, since 32% of TW's visual errors involve confusion of final letters, while only 17% involve confusion of initial letters, suffixes are clearly vulnerable to visual error simply because of their position in the word. The presence of a suffix does not increase the likelihood of error on that word but it does increase the likelihood that any error which occurs will affect the suffix rather than the stem, since the highest proportion (44%) of TW's visual errors involve confusion of medial letters, initial and final letters of the stimulus being retained in the response. There is no significant difference between the number of inflectional and the number of derivational errors to suggest that morphological errors form a genuine category. In the absence of any significant effect of the presence of a suffix on the probability of a word being read correctly, it is not possible to be certain that TW does in fact make genuine derivational and inflectional errors which would provide evidence for a morpheme-based visual word recognition system.

A further source of evidence on this issue is performance on the Inappropriately Suffixed Test of Nonword Reading. This test consists of high frequency root morphemes combined with illegal affixes (e.g. brighted, doggest) presented for reading aloud. If the Visual Word Representation System is indeed morpheme-based, one would expect that in this task the root morpheme would be recognised and read correctly and that the majority of errors, if errors are made, would occur on the affix which might be deleted or substituted.

TW read only 1 inappropriately suffixed item correctly but the larger proportion (54%) of errors, all of which are lexicalisations, are visual errors in which medial letters in the letter string are confused and the root morpheme is not read correctly (e.g. beatly -> "beauty"; happenly -> "happily"). Although the remaining errors (46%) do involve the affix (e.g. enjoyest -> "enjoyable"; problemer -> "problems") performance on this test does not provide convincing evidence for a morpheme-based visual recognition system. TW's performance on this test was compared with that of DP (Case Report II). In DP's case, there is conflicting evidence regarding the ability to use the direct route. DP's errors are compatible with a morpheme-based recognition system. She read 6/25 nonwords correctly and 54% of her errors (which like TW's are all lexicalisations) involve deletion or substitution of the suffix (e.g. <u>happenly</u> → "happening"; <u>firster</u> → "first"). This evidence is suggestive of a morpheme-based recognition system only if DP is indeed relying on the operation of the direct route for reading aloud. If the lexical-semantic route was involved in this task, these errors could arise following separation of the affix in the Morphological Decomposition System.

It is of note that TW's performance on the Inappropriately Suffixed Test (4% correct) and in the Reading of Affixes in Isolation Test (1% correct) offers no evidence to support Job and Sartori's (1984) hypothesis regarding the presence of "affix-recognisers" which should operate regardless of the absence or illegality of a stem.

4.4.7.3 **Comprehension of grammatical morphemes**

TW's comprehension of function words is somewhat impaired (72% correct) and tends to be poorer than his ability to read function words (95% correct in the Easy and 78% correct in the Revised Part of Speech Test). The dissociation between comprehension and reading ability is much more dramatic in the case of inflectional endings indicating tense. TW was not able to recognise the significance of past and present verb forms with any degree of accuracy in the Single Word Test of Morphological Knowledge. His score on this test yields a d' of zero.

4.4.7.4 The Nonword Reading Impairment

4.4.7.4.1 General comments

TW's scores on the Structured Nonwords Test, as in all nonword reading tests, are very low and performance shows no effect of type of nonword. In no subtest did he read more than 2 nonwords correctly. Types of error response are similar across all stimulus types. In each subtest the majority (90-100%) of error responses are lexicalisations; remaining errors are 1 omission and 1 incorrect nonword across all subtests. Performance on silent tests of phonology is poor in all tests. Scores on word and nonword versions of the Silent Test of Phonology I yield d' values close to or at zero as does performance on an additional test (III) in which TW was asked to indicate which of the nonwords in the Pseudohomophony I Test sound like real words. Performance was also poor in the Silent Test of Phonology II. TW showed little evidence of impairment in repetition tasks in which his scores ranged from 80-100% correct. Nonwords were repeated as efficiently as words and there is no effect of type of nonword. Thus TW's difficulty in reading aloud nonwords is not due to difficulty in articulating unfamiliar speech segments.

Performance on the Cross-case letter matching task (76% correct) indicates some impairment in the abstract letter recognition system, although this impairment is by no means severe enough to account for TW's very poor performance on reading nonwords. He was able to name 88% of letters presented singly and 70% of letters presented in a string.

4.4.7.4.2 The Phoneme Allocation System

There is no evidence that the Phoneme Allocation system is operational. No letter sounds were given in response to visually-presented letters and only 4/231 error responses (2%) are classified as incorrect nonwords.

4.4.7.4.3 The Resegmentation System

TW is able to segment words into component word units (93% correct on the Visual Segmentable Words Test). This task is not performed via phonological segmentation since TW's score was significantly lower on the auditory version of this task (57% correct).

In the segmentation tasks administered by Patterson and Marcel (see Chapter 1, Note 3), TW was able to underline common letters in pairs of words (92% correct). He was extremely impaired in identifying one or two letters in a letter-string which, when inserted into a gap in a second letter-string make it a word (Orthography (2) Test). Performance was lowest when the two letters to be segmented did not form a grapheme. Patterson and Marcel's interpretation of these results is not discussed here but it is noted that TW's performance on these tasks indicates some impairment of the Resegmentation System. Patterson (personal communication) notes that a potential problem with the Orthography II Task is that it depends upon an ability to spell. TW's spelling abilities are very poor and his spelling difficulties may have contributed to his low scores on this task.

4.4.7.4.4 The Blender

TW shows some limited ability to blend auditorily-presented phonemes to form words (42% correct) and a minimal ability to lend phonemes to form nonwords (performance at zero on the Sound Blending I Test but 11% correct on the Sound Blending II Test.[2] TW also shows a limited ability to blend words to form nonwords (40% correct on the Nonwords Synthesised from Words Test with colour cue). The scores indicate that the system is operational though severely impaired. Although correct items on the Sound Blending II Test are no longer than 2 phonemes in length, the difficulty is unlikely to be due to a deficit in auditory short term memory since TW has a digit span of 5 digits forward.

4.4.7.4.5 **Concluding comments**

As noted in the introduction to these case reports, the high proportion (97%) of lexicalisation errors is interpreted as indicating reliance on a lexical route for nonword as well as word reading. The phonological route is, on this account, almost totally non-functional. A lesion in one of the pathways within the phonological route is suggested by the almost total lack of output from this route. The site of this lesion is difficult to establish on the basis of results from tasks which do not require reading aloud of nonwords.

4.4.8 Summary

TW presents with a phonological dyslexia in which nonword reading is almost totally abolished. There is evidence of some impairment within the semantic system. This impairment is evident in comprehension tasks but not in reading tasks (no semantic errors are made). It is concluded that TW is able to use the direct route when reading words aloud.

<u>Notes for Case Report III</u>

1 In fact even if it were assumed that TW read aloud 8% of these items using the phonological route, and if these 6 items were then deducted from his reading total, the difference between reading and matching performance would remain highly significant (X^2 (1df) = 14.6, $P<.001$).

2 I note that these scores are higher than those obtained by Patterson and Marcel in Sound Blending Tasks administered to TW, in which he was unable to blend any nonwords correctly. This may be due to the length of nonword stimuli - Patterson and Marcel's nonwords in their Phonology (3) Task were 3 phonemes in length, the 4 nonwords in the Sound Blending II Test which TW blended successfully were all 2 phonemes in length.

4.5 Introduction to Case Reports IV - IX

Case Reports I - III describe patients in whom the phonological route is completely non-functional or very severely impaired such that a response is rarely produced via this route. Case Reports IV - IX describe patients in whom the phonological route, though moderately or severely impaired is to some extent operational. Levels of nonword reading range from 16% (ZS,Case Report VI) to 58% (WPB, Case Report IX). These patients were able to read sufficient items from the Structured Nonwords Test to enable conclusions to be drawn about the locus of impairment within the phonological route.

Testing was not completed in the case of FW and she did not complete the full Structured Nonwords Test. The available data suggests that her primary problem is within the resegmentation system. The resegmentation system is implicated as the primary locus of impairment in the case of WPB. PG's results give no clear indication of a single primary locus of impairment. In the remaining three cases the Phoneme Allocation System is implicated as the primary locus of impairment.

ZS, who is a native speaker of Polish was tested on word and nonword reading in both English and Polish. Phonological dyslexia is present in both languages.

Investigation of word-reading in this group of patients suggests that CB, ZS, PG and FW rely on the lexical-semantic route for reading words aloud, while JS relies on the direct route. WPB is also able to use the direct route although impairment of the lexical-semantic route appears to be minimal in this case. The relationship between reliance on one or other of these routes and performance on function words and affixed words is considered in each case.

4.6 Case Report IV: CB

4.6.1 Neurological Background

CB is a 39-year old, right-handed woman who sustained a CVA in October, 1980. She presented with a global aphasia and mild right hemiparesis and was referred to the Midland Centre for Neurosurgery and Neurology following admission to Good Hope Hospital. A left temporal craniotomy was performed and a clip placed on the ruptured left posterior communicating artery. By October, 1983, CB's right hemiparesis had resolved and she now writes with her preferred right hand. She has suffered occasional epileptic fits since her CVA and phenobarbitone has been prescribed to control seizures.

4.6.2 Educational and Occupational Background

CB initially left school after taking her 'O' levels but returned to College as a mature student and obtained 3 'A' level passes after which she trained as a State Enrolled Nurse. She read widely prior to her CVA and is still keen to discuss her interest in the classics of English literature. She is now able to read, with difficulty, books in the Hutchinson Spirals series which are used by the Right to Read scheme to encourage adult literacy. CB had no pre-trauma difficulty with writing and spelling, although the occasional spelling error may be observed in her writing. I quote briefly from essays submitted in the course of her nursing training (the spelling error in the first extract is underlined):

"Diabetes is a disease which although not hereditory, does tend to run in families. There is an ineffectiveness of the endocrine secretion of the pancreas - INSULIN, which is made in the Islets of Langerhans. The liver is therefore unable to store glycogen and the blood sugar rises and sugar appears in the urine. The kidneys require more water in which to dissolve this sugar so that there is POLYURIA (frequency in passing urine and GLYCOSURIA (sugar in the urine)."

"To encourage mobility the patient will receive physiotherapy - the nurse can help by using passive physiotherapy on the right arm and leg. The rt (abbreviation) leg can be flexed and straightened, the right foot could be pushed against the bottom of the bed or the nurse's hand. The foot should be supported at all times to prevent foot drop occurring and a bed cradle could be put into the bed to prevent the weight of the sheets bearing down on the leg."

4.6.3 Aphasia and Dysgraphia

Global aphasia has resolved into an aphasia in which spontaneous speech is characterised by word-finding difficulties and by the infrequent production of complete sentences. Word finding difficulty is indicated by pauses rather than by circumlocutions and an utterance frequently consists of a string of content words although there is occasional evidence of ability to structure sentences. For instance, when trying to explain that she could not offer me coffee because there was no milk she said "The kitchen .... oh .... the milk ....

milk.... the milkman ... coffee (shrugs shoulders)" and when explaining that her son was going on a school trip to France she said "Oh,... Nicholas ... Nicholas ....France ... the school ... Nicholas is going to France ....the 24th to the 26th ... a short visit ... and seeing new places ......"

More complex phrases were observed in the course of the following conversation about walking in the nearby park:

"It's so ... it's ... a thousand years in the future ... and ... and dinosaurs. I feel so ... it's so quick ... I am ...".
(Examiner: "There's a feeling of timelessness, isn't there?")
"Yes. <u>Yes</u>. The trees go on forever."

A copy of the BDAE Z-score profile of aphasia subscores for a test administered in February, 1984, is provided in Appendix I. Articulation is almost perfect and when longer phrases are produced, melodic line is normal and information is proportional to fluency.

Scores on the naming subtests of the BDAE are above the mean score in spite of word-finding difficulties in spontaneous speech. Repetition of words and high probability phrases is unimpaired and the score for repetition of low-probability material above the mean. Auditory comprehension scores on the BDAE subtests are above the mean but indicate some deficiency even at the single word level (65/72 in the word discrimination subtest); however, the points lost in this subtest were due to speed of response rather than to errors.

In the BDAE tests of reading comprehension CB scored full marks on the symbol discrimination, word recognition, and word-picture matching subtests and 8/10 on reading sentences and paragraphs. She performed poorly (2/8) on comprehension of oral spelling. Her oral reading at the word level was only minimally impaired (27/30) and she read 6/10 sentences.

Mechanics of writing are unimpaired. CB's score is above the mean for serial writing (44/47) and primer-level dictation (13/15) and written confrontation naming (5/10) but performance is poor on the spelling to dictation (1/10), sentences to dictation (1/10) and narrative writing (rating 1) subtests. The category of aphasia to which CB should be assigned on the basis of the BDAE results is unclear. In spite of occasional use of full sentences, aphasia appears to be more aptly labelled non-fluent than fluent but the sparing of melodic line and articulatory agility in conjunction with this occasional ability to use fairly complex grammatical constructions renders the label "Broca's aphasia" inappropriate.

There is an accompanying dysgraphia of moderate severity in which there is an inability to write nonwords (0/10) while simple high frequency words are written efficiently (10/10). Nouns (12/15) are written better than function words 6/19). There is no significant effect of imageability (high-imageable words 10/21, low-imageable words 5/21). This pattern of results suggests the presence of phonological dysgraphia.

4.6.4 Neuropsychological Baseline Tests

CB obtained a Memory Quotient of 72 on the Wechsler Memory Scale. Her digit span is 3 forward and 3 backward. CB named 46/60 items in the Boston Naming Test. She obtained an I.Q. equivalent of 125 in the spoken and 123 in the written version of the PPVT, which indicates good comprehension at the single word level. Auditory comprehension of prepositional relationships as measured by the Token Test is, however, severely impaired. CB scored 12.5/36 on the shortened version of this test.

4.6.5 Reading and Repetition Tests

The results of reading and repetition tests are shown in Tables 4.6.1 to 4.6.9. A transcription of CB's reading of the passage of text is provided in Appendix II. Error types are shown in Tables 4.6.10 to 4.6.12. Fig. 4.6.1 shows the effect of word length on reading speed. Percentages of errors falling into the main error categories and percentages of different types of response are shown graphically in Figures 4.6.2 to 4.6.5.

Table 4.6.1 READING AT THE SINGLE LETTER LEVEL

Number Test		Percentage Correct	Correct
Single letter naming	n = 26	24	92
Single letter sounding	n = 24	19	79
Single letters from a string	n = 20	20	100
Cross-case letter matching	n = 58	54	93

Table 4.6.2 READING AT THE SINGLE WORD LEVEL

Test	Number Correct	Percentage Correct	Significant effect of Variable
Easy lexical decision n = 50	50	100	
Difficult lexical decision n = 40	30	75	
Imageability (standard)			
High Imageable n = 28 & 20	27 & 20	96/100	-
Low Imageable n = 28 & 20	22 & 19	79/95	
Imageability (difficult)			
High Imageable n = 20	12	60	-
Low Imageable n = 20	10	50	
Part of speech (easy)			
Noun n = 20	20	100	-
Verb n = 20	19	95	
Adjective n = 20	18	90	
Function word n = 20	18	90	
Part of Speech (difficult)			
Noun n = 20	12	60	-
Verb n = 20	9	45	
Adjective n = 20	14	70	
Function word n = 20	9	45	
Part of speech (revised)			
Noun n = 25	25	100	-
Verb n = 22	22	96	
Adjective n = 25	24	96	
Function word n = 37	33	89	
Regularity of spelling (standard)			
Regular n = 39	31	79	-
Irregular n = 39	30	77	
Frequency			
High Frequency n = 23	23	100	-
Low Frequency n = 23	19	83	
Word length			
3-letter n = 10	10	100	-
4-letter n = 10	8	80	
5-letter n = 10	9	90	
6-letter n = 10	10	100	
7-letter n = 10	5	50	
8-letter n = 10	8	80	
Presence of Suffix I			
Suffixed n = 30	23	77	+
Unsuffixed n = 30	29	97	
Presence of Suffix II			
Suffixed n = 28	12	43	+
Unsuffixed n = 28	21	75	

Table 4.6.3 COMPREHENSION TESTS

Test	Number correct	Percentage correct
Synonym matching		
High Imageable n = 38	38	100
Low Imageable n = 38	32	84
Semantic Probe n = 16	15	94
Comprehension of functors n = 18	16	89

Table 4.6.4 TEST OF MORPHOLOGICAL KNOWLEDGE

Test	Number correct	Percentage correct
Single word test n = 32	20	63

Table 4.6.5 TESTS OF NONWORD PROCESSING

Test	Number correct	Percentage correct	Significant effect of Variable
Reading aloud			
Easy Lexical Decision			
Words n = 25	24	96	+
Nonwords n = 25	7	28	
Nonwords with inconsistent letters			
With inconsistent letter n = 36	10	28	+
Without inconsistent letter n= 36	19	53	
Nonwords synthesised from words			
with colour cue n = 10	4	40	-
without colour cue n = 10	2	20	
Segmentable words			
Visual mode n = 30	28	93	+
Auditory mode n = 30	13	43	
Hidden words n = 20	19	95	
Sound Blending I			
Words n = 24	19	79	+
Nonwords n = 8	0	0	
Sound Blending II n = 35	7	20	
Consistent and Inconsistent nonwords			
With consistent segment n = 15	8	53	-
With inconsistent segment n = 15	10	67	
Reading by analogy I:			
Deletion			
Type A nonwords n = 16	13	81	+
Type B nonwords n = 19	8	42	
Reading by analogy II:			
Substitution			
Type A nonwords n = 14	10	71	-
Type B nonwords n = 14	8	57	
Pseudohomophony I			
Pseudohomophones n = 15	6	40	-
Non-pseudohomophones n = 15	9	60	
Pseudohomophony II			
Pseudohomophones n = 10	5	50	-
Non-pseudohomophones n = 10	1	10	

Table 4.6.5 TESTS OF NONWORD PROCESSING (continued)

Test		Number correct	Percentage correct	Significant effect of Variable
Reading aloud				
difficult lexical decision				
words	n = 20	5	50	
Nonwords	n = 20	0	10	
Inappropriately suffixed nonwords	n = 25	3	12	
Affixes in isolation	n = 10	5	50	

Table 4.6.6 READING ALOUD NONWORDS OF DIFFERENT STRUCTURE

Type	Example	Number Correct	Percentage Correct
A	tad	12	60
B	ank	9	45
C	ead	6	30
D	eth	16	80
E	tood	6	30
F	dack	11	55
G	dunt	9	45
H	afe	7	35

n = 20 in each list

Table 4.6.7 READING ALOUD WORDS AND NONWORDS OF DIFFERENT STRUCTURE

Type	Percentage of words correct	Percentage of nonwords correct
A	100	60
E	90	10
F	90	40
G	100	40

n = 10 in each list

Table 4.6.8 SILENT TESTS OF PHONOLOGY

Test	Number correct	Percentage correct
Silent test of phonology I		
Nonword n = 50	34	68
Regular word n = 50	48	96
Irregular word n = 50	47	94
Silent test of phonology II n = 40	27	68

Table 4.6.9 TESTS OF REPETITION ABILITY

Test	Number correct	Percentage correct
Pseudohomophony I		
Words n = 15	14	93
Nonwords n = 15	15	100
Easy lexical decision		
Words n = 25	25	100
Nonwords n = 25	24	96
Nonwords of different structure		
Type A n = 10	10	100
Type B n = 10	9	90
Type C n = 10	10	100
Type D n = 10	10	100
Type E n = 10	10	100
Type F n = 10	9	90
Type G n = 10	10	100
Word and nonword repetition		
words n = 60	56	93
nonwords n = 60	51	85

Table 4.6.10 READING ERRORS - WORDS

		Number of errors	Percentage of errors
Visual		56	31
Sharing initial letter(s) with stimulus	37		
Sharing init. & fin. letter(s) with stimulus	19		
Visual or Semantic		5	3
Derivational		44	25
Suffix alteration	43		
Prefix alteration	1		
Derivational or Inflectional (ing)		13	7
Inflectional		12	7
Nouns	8		
Verbs	3		
Adjectives	1		
Function Word Substitutions		11	6
Visually similar	10		
Visually dissimilar	1		
Semantic		1	1
Other		36	20
Possibly visual,	1		
Completion	2		
Blending	6 (07)		
Regularisation	2		
Attempts to read via sub-lexical grapheme-phoneme conv.	3		
Substitution, addition or deletion of word segments	18		
Incomplete	3		
Bizarre	1		
TOTAL ERRORS		178	
Words misread		159	16
Omissions		3	0
Words read correctly		813	83
TOTAL PRESENTED		976	

		Error responses
corrected	13	
Additional errors due to multiple attempts		6

Table 4.6.11 READING ERRORS NONWORDS

		Number of errors	Percentage of errors
Lexicalisations		116	44
Visually similar to stimulus 95			
sharing initial letter(s) with stimulus	51		
sharing init. & fin.letter(s) with stimulus	27		
sharing final letter(s) with stimulus	14		
sharing medial letter(s) with stimulus	1		
sharing letters not in corresponding posns.	2		
Visually distinct from stimulus 21			
sharing initial letter(s) with stimulus	12		
sharing final letter(s) with stimulus	4		
sharing letter(s) not in corresponding posns.	5		
Incorrect nonwords		113	42
mixed/multiple errors of grapheme-phoneme conversion	38		
substitition, addition or deletion of word segments	9		
phonemic realisation of silent _e_	3		
failure of marking function of silent _e_	1		
addition of single grapheme phoneme	23		
omission of single grapheme/phoneme	4		
substitution of single grapheme/phoneme	35		
Other		37	14
Blending	24		
Letter identification	3		
Resegmentation	2		
Incomplete	6		
Complex lexicalisation	1		
Unclassified	1		
TOTAL ERRORS		266	
Nonwords misread		205	57
Omissions		1	0
Nonwords read correctly		151	42
TOTAL PRESENTED		357	
Corrections			19
Additional errors due to multiple responses			42

Table 4.6.12 TEXT READING ERRORS

	Number of errors	Percentage of errors
Errors on stem of content words (n = 56)	2	4
Derivational/inflectional errors on content words	4	7
Errors on function words (n = 69)	5	7
TOTAL WORDS IN PASSAGE	125	

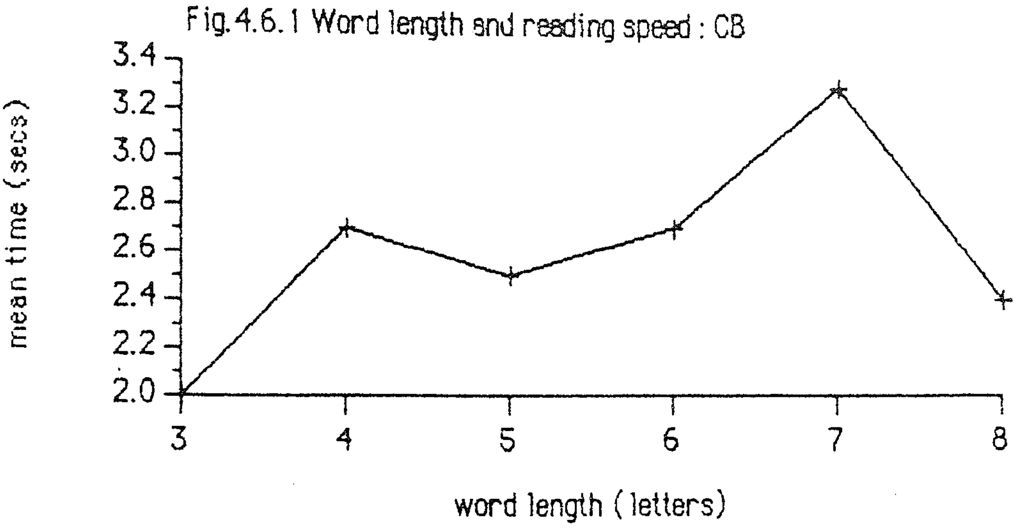

mean time (secs)
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
3
4
5
6
7
8
word length (letters)

Fig. 4.6.2 Reading responses to words : CB

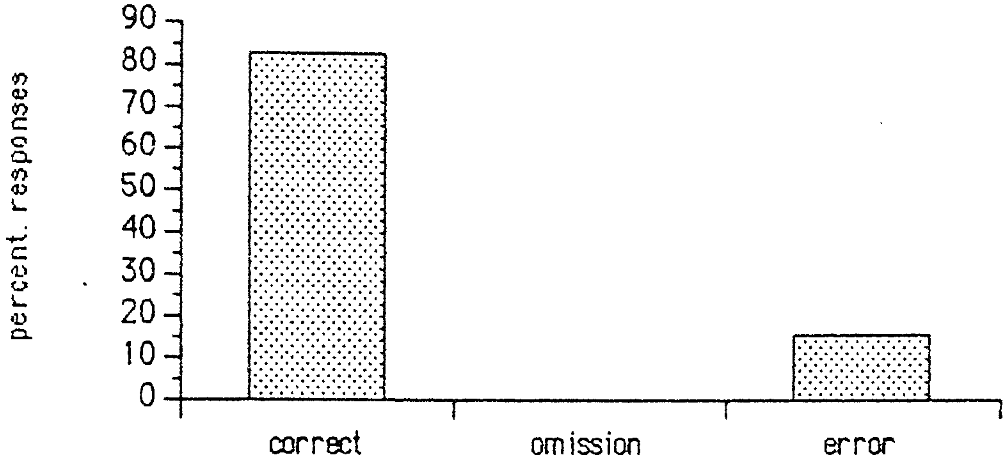


Fig. 4.6.3 Reading responses to nonwords : CB

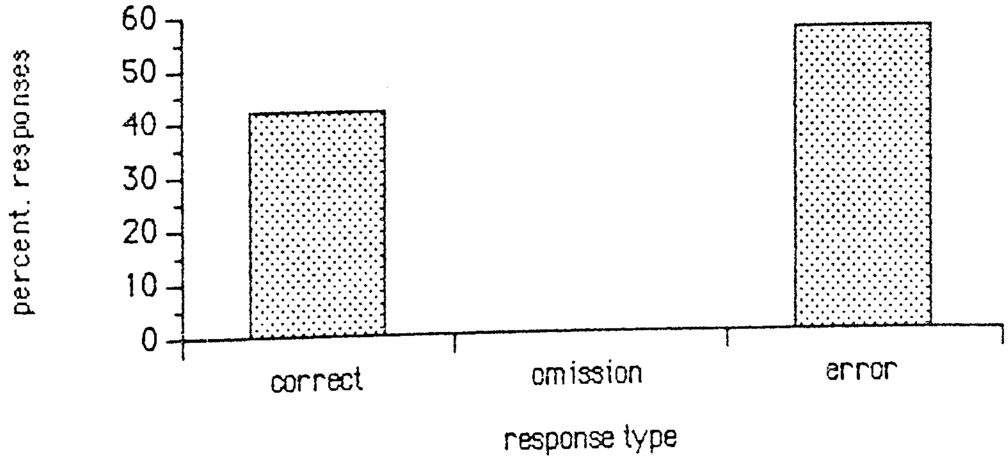


Fig. 4.6.4 Types of error response to words : CB

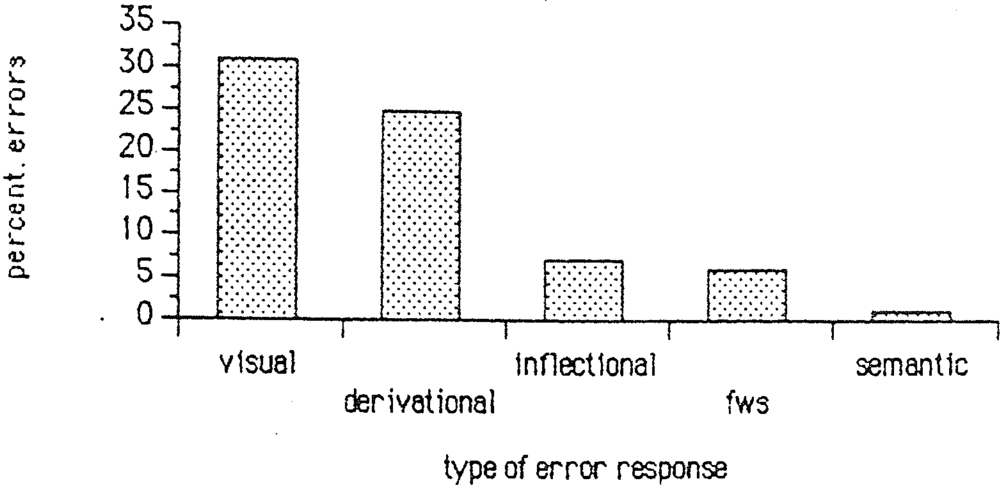
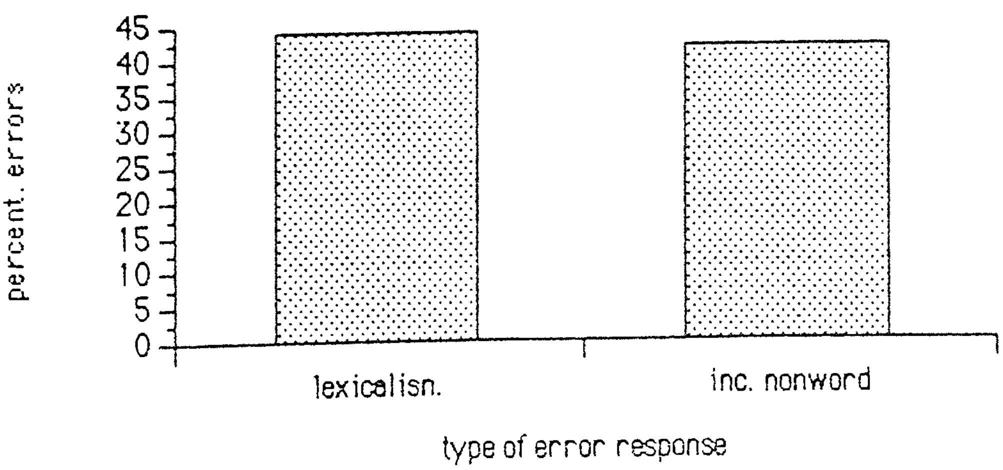


Fig. 4.6.5 Types of error response to nonwords : CB



4.6.6. Analysis of Test Results

4.6.6.1 **Reading at the Single Word Level**

There is no significant effect on performance of varying Regularity of Spelling (X^2 (1df) = .08, $P > .05$), Part of Speech (Easy Test = (X^2 (3df) = 2.3*, $P > .05$; Difficult Test, X^2 (3df) = 3.6, $P > .05$; Revised Test = X^2 (3df) = 3.8*, $P > .05$), Frequency ($Z = 1.55$, $P > .05$) or Word Length (Kendall's $S = -5$, $P > .05$). Word Length had no significant effect on reading speed (Kendall's $S = 4$, $P > .05$). There is no effect of Imageability at the single word level (Standard Test, 1st administration: $Z = 1.6$, $P > .05$; 2nd administration: $Z = 0$, $P > .05$; Difficult Test: X^2 (1df) = .4, $P > .05$).

There is a significant effect of the presence of a suffix in both tests involving this variable (I: $Z = 1.9$, $P < .01$; II: X^2 (1df) = 6, $P < .05$). Performance was 100% correct in the Easy Lexical Decision Task. In the Difficult Lexical Task, a Hit Rate of .6 and a False Alarm Rate of .05 yield a d' of 1.9.

4.6.6.2 **Tests of comprehension and morphological knowledge**

There is an effect of imageability in the Synonym Matching Task and in the reading aloud of items in this test ($Z = 2.1$, $P < .05$ in both tests). There is no significant difference between the score on the reading of items in the Synonym Matching Test and the score on the Matching task (scores are identical). The scores on the Semantic Probe Test (chance = 8 ± 4) and the Comprehension of Functors Test (chance = 9±3) are significantly above chance. In the Single Word Test of Morphological Knowledge, a Hit Rate of .4 and a False Alarm Rate of .1 yield a d' of 1.02.

4.6.6.3 Tests of nonword processing

CB's word reading scores are significantly higher than nonword reading scores (Reading aloud Easy Lexical Decision: X^2 (1df) = 24.5, $P<.001$; Reading aloud Difficult Lexical Decision: $Z = 1.9$, $P<.05$; Reading aloud Words and Nonwords of Different Structure: X^2 (1df) = 29.6, $P<.001$).

There is a significant effect of type of nonword in the Structured Nonword Test (X^2 (7df) = 16.5, $P<.05$). Nonwords which did not contain inconsistent letters were read significantly better than those which did contain inconsistent letters (X^2 (1df) = 4.7, $P<.05$). There is no significant effect of the presence of an inconsistent segment (X^2 (1df) = .5, $P>.05$). There is no significant effect of pseudohomophony (I: X^2 (1df) = 1.2, $P>.05$, II: $Z = 1.4$, $P>.05$). In the Reading by Analogy I Test, Type A nonwords were read significantly better than Type B nonwords (X^2 (1df) = 5.9, $P<.05$); in the Analogy II Test there is no significant difference between Type A and Type B nonwords (X^2 (1df) = .6, $P>.05$). Significantly more words than nonwords were blended correctly in the Sound Blending I Test ($Z = 3.5$, $P<.001$). There is no significance difference between scores on nonwords presented with and without colour cues in the Nonwords synthesised from Words Test ($Z = .48$, $P<.05$). In the Segmentable Words Test the score in the Visual Version of the test is significantly higher than the score in the Auditory Version (X^2 (1df) = 17.3, $P<.001$). There is a significant effect of type of nonword in the Nonwords of Different Structure Test (X^2 (7df) = 16.5, $P<.05$). In the Silent Test of Phonology I, Nonword Version, a Hit Rate of .6 and a False Alarm Rate of .2 yield a d' of 1.1. The d' statistic is higher in both word versions of this test (Regular Word: Hit Rate =.9, False Alarm Rate = 0, d' = 3.6, Irregular Word: Hit Rate = .9, False Alarm Rate = 0, d'= 3.6). In the Silent Test of Phonology II, CB obtained a Hit Rate of .9, and a False Alarm Rate of .3, yielding a d' of 1.8.

4.6.6.4 Tests of repetition ability

There is no difference between scores on words and nonwords in the Pseudohomophony I Test, ($Z = 0$, $P>.05$), or the Easy Lexical Decision Test ($Z = 0$, $P>.05$). There is no effect of Type of Nonword in the Nonwords of Different Structure Test (error rates too low to permit statistical analysis).

4.6.6.5 Reading errors: Words

The highest proportion of errors (31%) made by CB are Visual. However, there is no significant difference between the number of errors in this category and the number of errors in the Derivational category, which account for 25% of total errors (X^2 (1df) = 1.4, $P<.05$). If errors of the Inflectional and Derivational Type are combined, they account for 39% of total errors, a proportion which exceeds that of the Visual Error category, although the difference is not significant (X^2 (1df) = 1.4, $P>.05$). Significantly more errors are classified as Derivational than are classified as Inflectional (X^2 (1df) = 18.3, P<.001). Significantly more Function Word Substitutions are visually similar to the stimulus than are visually distinct (X^2 (1df) = 7.4, P<.01).

4.6.6.6 Reading Errors: Nonwords

Lexicalisations account for 44% and Incorrect Nonwords for 42% of total errors. There is no significant difference between the numbers of errors in these two categories (X^2 (1df) = .04, P> .05). Significantly more lexicalisation errors are visually similar to the stimulus than are visually distinct (X^2 (1df) = 47.7, P<.001).

4.6.6.7 Reading Errors: Text

There is no significant difference between the number of errors made on the stems of content words and the number of errors made on function words in reading the passage of text (Z = .5, P>.05).

4.6.7 Discussion of Reading Impairment

4.6.7.1 Reliance on the lexical-semantic route for reading aloud

4.6.7.1.1 General comments

There is no evidence that CB is able to use the direct route for reading aloud words. On no occasion does a reading aloud score exceed a comprehension score and in one of the investigations which follows the comprehension score is significantly better than the reading aloud score. Comprehension of single written words is generally good, as evidenced by an I.Q. equivalent of 123 in the written version of the PPVT, a score of 94% correct on the Semantic Probe Test, and an overall score of 92% correct on the Synonym Matching Task. In the latter task CB did not read correctly any items on which she was unable to make the correct matching judgement. Imageability affects performance on both reading and comprehension tasks in the Synonym Matching Task. There is no significant effect of Imageability in either the easy or difficult Imageability Test, although the score obtained on high-imageable items is, in each case, greater. It seems that this variable does have an effect upon performance but that this effect is slight and possibly unstable (compare scores obtained on the first and second presentations of the Imageability Test). Nevertheless, any effect of this variable on reading performance provides additional evidence for reliance on the lexical-semantic route. One further observation which suggests semantically-mediated reading is CB's tendency to read words with appropriate tone of voice, or accompanying gesture or facial expression thus demonstrating that comprehension precedes production.

4.6.7.1.2 Additional comparisons of reading and comprehension performance

4.6.7.1.2.1 Introduction

Since equal scores on reading and comprehension tasks are compatible with a state of affairs in which both the lexical-semantic and the direct routes are operational, further investigation of performance on the two tasks was undertaken in order to establish whether or not there is reliance on one or other route. Where comprehension scores exceed reading scores reliance on the lexical-semantic route is suggested. Where reading scores exceed comprehension scores it is clear that the direct route is in use.

4.6.7.1.2.2 Test One

CB was presented with the 20 irregularly spelled items from the Difficult Regularity Test. She was asked to read each word aloud and then to define it. She read 16/20 words correctly and defined 19/20 correctly, the 3 words which she was able to define but not read aloud correctly being memoir, chronic and concert. The difference between scores in the two tasks does not reach significance (X^2 (1df) = .9, P> .05) and the results are therefore inconclusive though suggestive of reliance on the lexical-semantic route.

4.6.7.1.2.3 Test Two

CB had obtained a high score (133/150) on the written version of the PPVT when it was first administered. This comprehension test was administered a second time (since nearly a year had elapsed since the first administration) commencing at Plate No. 71. Immediately after this second administration CB was presented with the words which she had defined (in random order) and asked to read them aloud. Items and responses are shown in Table 4.6.17.

Table 4.6.17 PPVT Comprehension and Reading Aloud

Plate No.	Word	Comprehension	Reading Response	Type of Reading Error
71	casserole	+	+	
72	ornament	+	+	
73	cobbler	+	+	
74	autumn	+	+	
75	dissatisfaction	+	+	
76	scholar	+	+	
77	oasis	+	+	
78	soldering	+	soldered	Derivational/ Inflectional
79	astonishment	+	astonishing	Derivational/ Inflectional
80	tread	+	thread	Visual
81	thatched	+	thatcher/ thatching	Derivational/ Inflectional
82	jurisprudence	+	-	Omission
83	sapling	+	sap - ill	Segmentation & Visual
84	arch	+	+	
85	dwelling	+	+	
86	lubricating	+	lubrication	Derivational/ Inflectional
87	pedestrian	+	+	
88	vale	+	+	
89	jubilant	+	jubilance	Derivational
90	laden	+	+	
91	pursuit	+	pursue	Derivational
92	goblet	+	+	
93	rodent	+	+	
94	confiding	+	confidence	Derivational
95	reclining	+	+	
96	frisking	+	+	
97	moat	+	+	
98	salutation	+	salvation	Visual
99	barrier	+	+	
100	foal	+	+	
101	incandescent	-	-	Omission
102	cornucopia	-	corn - cobra	Segmentation & Visual
103	ascending	+	+	
104	summit	+	+	
105	caster	+	cassette	Visual
106	lobe	+	+	
107	patriarch	+	patriot	Visual
108	sampler	+	+	Visual
109	ingenious	+	+	
110	repose	+	+	
111	constrain	+	con - train & Visual	Segmentation
112	tangent	-	tangible	Visual
113	sconce	+	scone	Visual
114	hoary	+	horny	Visual

Table 4.6.17 PPVT Comprehension and Reading Aloud (continued)

Plate No.	Word	Comprehension	Reading Response	Type of Reading Error
115	pendant	+	+	
116	prodigy	+	protege	Visual
117	casement	+	+	
118	quiescent	-	_	Omission
119	talon	+	∓	
120	chevron	-	/'tʃɛvən/	?
121	feline	+	+	
122	cairn	+	caring	Visual
123	covergence	-	converge	Derivational
124	apothecary	+	+	
125	indigent	-	indigestion, ingest	Visual
126	edifice	+	efface	Visual
127	scallion	+	/'skʌli-ɪn/	?
128	infirm	+	+	
129	emaciate	+	emaciated	Derivational
130	catapult	+	+	
131	arable	+	arrival	Visual
132	orifice	-	office	Visual
133	renovate	-	removal	Visual
134	precarious	+	+	
135	dromedary	+	+	
136	pedagogue	+	-	Omission
137	sepal	+	sepulchre	Probably Visual
138	lethargic	+	+	
139	delectation	-	delectable	Derivational
140	embellish	+	+	
141	osculation	+	/ɒz....../	Incomplete
142	cincture	-	+	
143	barrister	+	+	
144	carrion	+	carry - on	Segmentation & Visual
145	lanate	-	lamp - ant	Segmentation & Visual
146	chiriography	-	..graph ..	Incomplete
147	mendicant	-	+	
148	saltation	+	salt ...	Incomplete
149	florescence	+	fluorescent	Visual
150	culver	-	culvert	Visual
	TOTALS	65	39	16 Visual 16
				Probably Visual 1
				Derivational/ Inflectional 10
				Segmentation & Visual 5
				Incomplete 3
				Other 2
				Omission 4
				41

CB picture-matched 81% of these items correctly, but read aloud only 49%. Ten of her errors were classified as derivational/inflectional. It is possible that correct picture matches may be chosen in this test even if an error of this type has preceded semantic judgement (for instance a jubilant character is exhibiting jubilance). Therefore these derivational errors were added to the total correct score in the reading task, increasing the score to 49/80 (61%) correct. Even after this manipulation, the score on the comprehension task is significantly higher than the score on the reading task (X^2 (1df) = 7.8, P<.01). CB did not read aloud any item which she was unable to define. The results of this test are compatible with reliance on the lexical-semantic route for reading aloud[1].

4.6.7.1.3 **The absence of Part of Speech effect**

Since CB relies on the lexical-semantic route for reading aloud, it is interesting to note that there is no effect of Part of Speech in her reading performance. In particular, the absence of a function word deficit is relevant to Patterson's (1982) suggestion that the semantically-mediated route is not particularly efficient at dealing with grammatical morphemes (see Chapter Two for discussion). There are very few function word substitutions in CB'serror corpus (these account for 6% of total errors) and all but one of these errors (been --> "has") are visually similar to the stimulus so that it is possible that this is not a "true" error category and that these errors are in fact visual in origin. There is no evidence of a function word deficit in CB's reading of the passage. Thus this case appears to demonstrate that reliance on the lexical-semantic route does not necessarily predict poor performance on function words. There is a caveat here, however. Unlike the patients discussed in Case Reports I - III, CB is able to make some use of the phonological route. She read correctly 42% of the nonwords with which she was presented. It is therefore possible that the phonological route is, to a limited extent, involved in the reading of functors and compensates for the inefficiency of the lexical-semantic route in dealing with grammatical morphemes.

There is little evidence of semantic impairment where the highly-meaningful function words used in the Comprehension of Functors Test are concerned. CB scored 16/18 (89%) in this test.

4.6.7.1.4 Derivational and Inflectional Errors

When Derivational and Inflectional error categories are combined, this error type accounts for the largest proportion (39%) of CB's reading errors. There is a significant effect of the presence of a suffix in both tests which manipulate this variable. Although some affixes are produced gratuitously, the larger proportion (54%) of derivational and inflectional errors occur in response to derived and inflected word forms. There is no reason to doubt that this is a genuine error category in this case. CB's performance on Lexical Decision dropped from 100% correct in the Easy Lexical Decision Task to 86% (Hit Rate = .9, False Alarm Rate = .2, d' = 2.12) correct in a Lexical Decision Task containing stems from the Inappropriately Suffixed Nonwords Test matched with appropriately suffixed items. She obtained a very low score on reading Inappropriately Suffixed Nonwords (12% correct) and her score of 50% correct on reading affixes in isolation is no higher than the scores obtained on a number of other nonword reading tests. Furthermore, significantly more derivational than inflectional errors appear in the error corpus. The distinction between these two error types is a linguistic one and there is no reason why visual confusion should lead to one type rather than the other.

Since CB is not relying on the direct route for reading aloud, this pattern of performance is not relevant to the locus of the morphological decomposition system. The feature which is of particular interest in this case is the dissociation between the reading of function words which is not impaired and the reading of affixes which is severely impaired. The caveat regarding the ability to make some use of the phonological route in reading grammatical morphemes is as applicable to the reading of affixes as it is to the reading of function words. However, it is clear that this route is not used in processing affixes. There is no reason why performance on reading aloud inappropriately suffixed nonwords should be so much poorer than performance on other nonword tests if the route were used in affix reading.

The nature of CB's errors on affixed words indicate that morphological decomposition takes place and that the stem of the word is normally processed efficiently. In 20/25 (80%) errors on affixed words and 20/23 (87%) errors on inappropriately suffixed nonwords the stem is retained and the error involves deletion or substitution of the affix. Occasionally an inappropriately affixed word is produced as a

Good performance on nonword repetition tests and poor performance on nonword versions of Silent Tests of Phonology indicate that the problem is not due to difficulty in articulating unfamiliar segments. There is no significant effect of pseudohomophony on performance.

4.6.7.2.2 The abstract letter recognition system

CB's score of 93% on the Cross-Case Letter Matching Task indicates that this system is intact. CB was also able to name 92% of single letters correctly in the Letter Naming Task and to name 100% of single letters correctly when letters were presented in a string.

4.6.7.2.3 The Locus of Impairment within the Phonological Route: Nonwords of Different Structure Test

CB read 48% of the nonwords in this test and there is a significant effect of stimulus type. Excluding Type A nonwords which provide a baseline measure, the highest scores are on Type D or Type F nonwords, which contain consonant units and the lowest scores are on Type C and Type E nonwords which contain a vowel digraph. This pattern is compatible with an impairment of the Phoneme Allocation System. The important comparison in this case is, therefore, between performance on Type C and E nonwords and Type D and F nonwords. Stimuli in subtests C and D and subtests E and F are matched for length and items in each subtest contain one grapheme that is represented by 2 letters. Type C and E nonwords contain vowel digraphs and Type D and F nonwords contain consonant units. The score on (D + F) is significantly greater than the score on (C + E), (X^2 (1df) = 11.2, $P <$ .001).

Error types do not provide corroborative evidence for damage to the Phoneme Allocation system. It is, in fact, difficult to predict the errors which would result directly from impairment of this system other than random misconversions of graphemes. Alternative (less common) phonemic realisations of graphemes are not counted as errors. The errors which CB made on subtests C and E are of the following types (numbers given include multiple responses): Lexicalisation (18); Misconversion of grapheme(s) (2); Blending (5); Resegmentation (1); Resegmentation and Blending (3); Blending and Misconversion of grapheme(s) (5); 34 errors in all. Of the errors on items C and E which are incorrect words and which are not classified simply as Blending errors (11 in all) 27% involve the vowel digraph, 27% involve another grapheme and 45% involve the digraph and another grapheme. Errors made on subtests D and F are of the following types: Lexicalisation (8); Misconversion of grapheme(s) (4); Blending (3); Blending and Misconversion of grapheme(s) (2); 17 errors in all. It is assumed (see Chapter Three) that these miscellaneous errors occur because stimuli which require the action of an impaired processor utilise more of the available processing capacity. Although corroborative evidence from inappropriate errors is desirable, its absence does not therefore, undermine conclusions regarding the locus of impairment. The significant effect of stimulus type strongly supports the conclusion and is not susceptible of alternative explanation.

4.6.7.2.4 The Locus of Impairment within the Phonological Route: Additional Evidence

4.6.7.2.4.1 Nonwords with Inconsistent Letters and Inconsistent Segments

There is a significant effect of the presence of an inconsistent letter, nonwords which do not contain such a letter being read more efficiently than those which do. This effect supports the conclusion that the Phoneme Allocation System is impaired. There is no significant effect of the presence of an inconsistent segment. Thus CB's sensitivity to inconsistent letters cannot be explained in terms of Lexical Analogy Theory.

4.6.7.2.4.1 Single Letter Sounds

CB gave the correct phonemic response to a visually presented letter on 19/24 (79%) occasions. The possibility of dissociation between letter sounding and nonword reading has already been noted. In this case, CB's speech therapist reports that she was initially unable to sound any letters and that correspondences have been retaught over the 3 years during which CB have been attending therapy sessions.

4.6.7.2.4.2 The Resegmentation System

There is evidence independent of the Structured Nonwords Test of ability to segment visually-presented letter strings. CB was able to find words hidden in a nonword letter string efficiently (Hidden Words

Test 95% correct). She obtained a score of 93% correct in the Visual Version of the Segmentable Words Test. The score on this version of the test is significantly higher than the score on the auditory version indicating that the high score is not due to the use of an auditory segmentation strategy. In an additional test CB was presented visually with all 100 words from the Structured Word Test (Chapter 3, Section 1.5.2) and asked to give the number of sounds rather than the number of letters in each word. She gave the correct number of phonemes in response to 91/100 items. The high score suggests that the resegmentation system is not seriously impaired although it is possible though unlikely in view of the low score on the auditory Segmentable Words Test, that the task, which was performed rather slowly, was performed by a process of auditory segmentation.

4.6.7.4.3 **The Blender**

Performance on auditory Sound Blending Tests using nonwords stimuli was poor (20% correct on the Sound Blending II Test; zero on Sound Blending I Test). When stimuli were words, performance was much more efficient (79% on Sound Blending I). Good performance on nonwords would have provided less equivocal evidence for the unimpaired operation of the Blender (Chapter 3, Section 1.5.8). Scores on the Nonwords Synthesised from Words Test are also fairly low, even when the colour cue is provided (40% correct). Thus there is no clear evidence independent of successful nonword reading performance that the Blender is not impaired.

4.6.7.2.4.4 Reading by Analogy Tests

There is no significant effect of stimulus type in the second test. In the first test, Type A nonwords (in which deletion of a phoneme is the only operation required) are read significantly better than Type B nonwords (in which residual phonemes require manipulation following the deletion of a phoneme). The difference in scores suggests that CB has difficulty in manipulating the phonological representation obtained lexically. That this is so is borne out to some extent by the errors made - 6/11 errors are the result of a misconversion of the grapheme which requires an alternative manipulation (e.g. moon -> /moo n/).

4.6.7.2.4.5 Error types

The pattern of nonword reading errors is compatible with impairment of the Phoneme Allocation System. Of the responses produced which are Incorrect Nonwords 58% are due to the misconversion of a single grapheme, while 34% involve mixed or multiple errors of grapheme-phoneme conversion. Lexicalisation errors occur in a lower proportion than in the error corpora of patients who are totally unable to use the phonological route (Case Reports I - III). In fact, although all word responses are classified as lexicalisations, 70/116 (60%) could have resulted from the deletion, addition or substitution of a single grapheme (e.g. breat -> "brief"; trin -> "trip"). If this is the case, the proportion of lexicalisation errors is much lower - 17% of total errors. These unequivocal lexicalisation responses tend to be produced in response to longer nonwords (e.g. larnter -> "lighter, no"; dimeocrities → "diamond, no, demented, no"). It is assumed that the impaired phonological route could produce no output for these items.

The "other" category includes 24 Blending errors and an additional 30 errors contain a Blending error as well as another error type. These errors may indicate impairment of the Blender but could also result from malfunctioning of the Phoneme Allocation System if, for example, the impaired subsystem outputs units for blending singly rather than in parallel.

4.6.8 Summary

The phonological route is severely impaired but not entirely non-functional in this case. The major impairment within this route is within the Phoneme Allocation System. The lexical-semantic route is used for reading words aloud as evidenced by the superiority of comprehension over reading ability and a slight effect of imageability on reading performance. A dissociation between processing of affixes and processing of function words is evident in CB's word reading.

Notes for Case Report IV

1 The 16 visual errors which CB made on the reading task in this test are somewhat difficult to explain in association with her good comprehension performance. It is not plausible that difficulty in accessing an oral word representation by means of a semantic representation would give rise to visual errors. The errors in such a case would surely be semantic. Visual word representations must be accessible since they are accessed in the comprehension task. The alternative account of visual errors (see Chapter Two) is that they arise through difficulty in addressing the semantic system. It may be that in this case, some semantic representations do have raised thresholds but that the pictures used in the comprehension task provide additional information

which eases access to these semantic representations.

2 This accompanying deficit in syntactic awareness is evident in a task described elsewhere (Bradley, 1984) in which CB was required to read aloud short sentences, half of which were morphologically well-formed and half of which were morphologically incorrect. The majority of CB's responses (58%), regardless of the morphological status of the stimulus, were ill-formed.

4.7 Case Report V: JS

4.7.1 Neurological Background

JS, a 58-year old, right-handed woman sustained a CVA in July, 1983. No information regarding site of lesion is available. The lesion was assumed to be in the left hemisphere, on the basis of the presence of a severe aphasia and a right hemiplegia which necessitated writing with the non-preferred hand. JS died in January, 1985.

4.7.2 Educational and Occupational Background

JS received 9 years of schooling and worked only intermittently since her marriage (for example, as a canteen assistant). She was, however, a keen reader before her stroke, particularly enjoying historical novels of which she had read a great number. Her writing consisted mainly of letters to members of her family; she had had no pre-trauma difficulty with writing or spelling.

4.7.3 Aphasia and Dysgraphia

Subsequent to her CVA, JS was referred to a speech therapist at Good Hope Hospital who diagnosed transcortical sensory aphasia. The profile obtained from the BDAE (a copy of the Z-score profile is provided in Appendix I), shows unimpaired repetitition of high and low probability sentences. In addition, JS was able to repeat longer, more complex sentences than those included in the BDAE, although her responses contained some literal paraphasias, which were not counted as errors. Auditory comprehension was somewhat impaired at the single word level (60/72) and poor when more complex material was presented (commands 3/15, complex ideational material 5/12). Naming was impaired in all tasks (responsive naming 18/20; confrontation naming 70/105; animal naming 3; body part naming 8/30). Oral reading was relatively well preserved especially at the single word level (word reading 18/30; sentence reading 6/10), but reading comprehension was very poor even at the single word level (word-picture matching 6/10), dropping to zero at the sentence level. Automatic speech was only mildly impaired (automatic sequences 6/8). Spontaneous speech was somewhat less fluent than is typically associated with transcortical sensory aphasia (Albert et al., 1981) although phrases containing 6 or 7 words are occasionally produced; the case could accordingly be described as a mild mixed transcortical aphasia with the major impairment on the sensory side. Frequent neologistic and verbal paraphasias occur in spontaneous speech. JS never initiates conversation and requires a lot of encouragement to speak at length. The following examples of spontaneous speech were elicited by asking her to talk about picture cards from the Minnesota Aphasia Test (Schnell, 1965).

Picture Card 11 "A /si/ is drawing a /faiv/. A..., a...., a/ri/, no, and a /su/ is /'səsən/ (pointing to boy in tree). And then that's a road (pointing to duck on duckpond). A/'pruro·ɷd/ and J. Smith (pointing to sign). And .... (pointing to house). (Examiner: Yes, that's where they live. And what about this? (man flying kite)). It's a /si / /sa/ this are throwing him about."

Picture Card 4 "It's a /si / is getting the flowers (pointing to boy on roof). Getting for the /poꝏs'wɛs weɩ /. (Examiner: Yes, and what else is in the picture?) The /weɩ̯/. I don't know."

Although there is no evidence of echolalia in attempts at social communication, JS tends to produce inappropriate echolalic responses under certain test conditions. For instance, in the paired-associate learning task in the Wechsler Memory Scale, she tended to echo the single word probe rather than produce the correct paired-associate response, even though she had performed the task correctly during preliminary explanation. If she was reminded of the task after producing an echolalic response ("No - what was the word that went with it?") she was able to respond correctly on several occasions (these responses were counted as correct when scoring the test).

JS's written spelling is severely impaired. She misspelled 70% of dictated items with which she was presented. There is no significant difference between performance on short high frequency words (5/10) and nonwords (2/10). She wrote 9/10 single letters in response to dictated letter names and 9/10 single letters in response to dicated phonemes. Thus there is evidence of ability to make phoneme-grapheme conversions. Spontaneous writing is very poor and suggests that the difficulty in converting "initial thought into sentences to form propositions" which is, according to certain accounts, the basic defect in transcortical motor aphasia (Albert et al., 1981) is present in this case. When asked to write about what she did at Christmas JS wrote:

"The Xmas strew for the a Light door wash to". While writing the first 7 words she was verbalizing. She was attempting to write "The Christmas tree forgot to send a light."

4.7.4 Neuropsychological Baseline Tests

JS obtained a score of 15 on the shortened version of the Token Test indicating a severe impairment of auditory comprehension. Comprehension of single words was also impaired as indicated by an IQ equivalent of 85 on the spoken version of the PPVT. Comprehension of visually-presented single words was somewhat less impaired; she obtained an IQ equivalent of 94 on a written version of the PPVT. Memory Quotient, obtained on the Wechsler Memory Scale is 66. Performance on the Logical Memory Subtest was particularly poor. JS's score on the Boston Naming Test is, like scores on naming subtests within the BDAE, very low. JS named only 17/60 items correctly.

4.7.5 **Reading and Repetition**[1]

The results of reading and repetition tests are shown in Tables 4.7.1 to 4.7.9. A transcription of JS's reading of the passage of text is provided in Appendix II. Error types are shown in Tables 4.7.10 to 4.7.12. Figure 4.7.1 shows the effect of word length on reading speed. Proportions of errors falling into the main error categories and proportions of different types of response are shown in Figures 4.7.2 to 4.7.5.

Table 4.7.1 READING AT THE SINGLE LETTER LEVEL

Number Test		Percentage Correct	Correct
Single letter naming	n = 26	18	69
Single letter sounding	n = 24	1	4
Single letters from a string	n = 20	16	80
Cross-case letter matching	n = 58	48	83

Table 4.7.2 READING AT THE SINGLE WORD LEVEL

Test	Number Correct	Percentage Correct	Significant effect of Variable
Easy lexical decision n = 50	26	52	
Difficult lexical decision n = 40	23	56	
Imageability (standard)			
High Imageable n = 20	17	85	-
Low Imageable n = 20	13	65	
Imageability (difficult)			
High Imageable n = 20	14	70	
Low Imageable n = 20	15	75	
Part of speech (easy)			
Noun n = 20	15	75	-
Verb n = 20	17	85	
Adjective n = 20	14	70	
Function word n = 20	20	100	
Part of Speech (difficult)			
Noun n = 20	14	70	+
Verb n = 20	15	75	
Adjective n = 20	12	60	
Function word n = 20	20	100	
Regularity of spelling (standard)			
Regular n = 39	27/27[a]	69/69	-
Irregular n = 39	26/24[a]	67/59	
Frequency			
High Frequency n = 23	17	74	-
Low Frequency n = 23	17	74	
Word length			
3-letter n = 10	7	70	-
4-letter n = 10	7	70	
5-letter n = 10	4	40	
6-letter n = 10	7	70	
7-letter n = 10	9	90	
8-letter n = 10	5	50	
Presence of Suffix I			
Suffixed n = 30	27	90	-
Unsuffixed n = 30	27	90	
Presence of Suffix II			
Suffixed n = 28	25	89	-
Unsuffixed n = 28	22	79	

a This test was administered on two occasions in order to establish whether or not there was consistency of performance.

Table 4.7.3 COMPREHENSION TESTS

Test	Number correct	Percentage correct
Synonym matching		
High Imageable n = 38	29	76
Low Imageable n = 38	19	50
Semantic Probe n = 16	7	44
Comprehension of functors n = 18	16	89

Table 4.7.4 TESTS OF MORPHOLOGICAL KNOWLEDGE

Test	Number correct	Percentage correct
Single word test n = 32	14	44

Table 4.7.5 TESTS OF NONWORD PROCESSING

Test	Number correct	Percentage correct	Significant effect of Variable
Reading aloud			
Easy Lexical Decision			
Words n = 25	19	76	+
Nonwords n = 25	11	44	
Nonwords with inconsistent letters			
With inconsistent letter n = 36	5	14	-
Without inconsistent letter n= 36	10	28	
Nonwords synthesised from words			
with colour cue n = 10	2	20	-
without colour cue n = 10	5	50	
Segmentable words			
Visual mode n = 30	24	80	+
Auditory mode n = 30	12	40	
Hidden words n = 20	6	30	
Sound Blending I			
Words n = 24	11	46	-
Nonwords n = 8	1	13	
Sound Blending II n = 35	10	29	
Consistent and Inconsistent nonwords			
With consistent segment n = 15	3	20	-
With inconsistent segment n = 15	5	33	
Reading by analogy I:			
Deletion			
Type A nonwords n = 12	5	42	-
Type B nonwords n = 17	1	6	
Reading by analogy II:			
Substitution			
Type A nonwords n = 10	6	60	-
Type B nonwords n = 10	5	50	
Pseudohomophony I			
Pseudohomophones n = 15	9	60	-
Non-pseudohomophones n = 15	5	33	
Pseudohomophony II			
Pseudohomophones n = 10	7	70	-
Non-pseudohomophones n = 10	3	30	

Table 4.7.5 TESTS OF NONWORD PROCESSING(continued)

Test		Number correct	Percentage correct	Significant effect of Variable
Reading aloud difficult lexical decision				
Words	n = 20	14	70	
Nonwords	n = 20	2	10	
Inappropriately suffixed nonwords	n = 25	19	76	
Affixes in isolation n = 10		8	10	

Table 4.7.6 READING ALOUD NONWORDS OF DIFFERENT STRUCTURE

Type	Example	Number correct	Percentage correct
A	tad	13	65
B	ank	10	50
C	ead	7	35
D	eth	16	80
E	tood	7	35
F	dack	9	45
G	dunt	10	50
H	afe	9	45

n = 10 in each list

Table 4.7.7 READING ALOUD WORDS AND NONWORDS OF DIFFERENT STRUCTURE

Type	Percentage of words correct	Percentage of nonwords correct
A	80	60
E	80	20
F	60	20
G	80	40

n = 10 in each list

Table 4.7.8 SILENT TESTS OF PHONOLOGY

Test	Number correct	Percentage correct
Silent test of phonology I		
Nonword n = 50	30	60
Regular word n = 50	30	60
Irregular word n = 50	31	62
Silent test of phonology II n = 40	27	68

Table 4.7.9 TESTS OF REPETITION ABILITY

Test	Number correct	Percentage correct
Pseudohomophony I		
Words n = 15	14	93
Nonwords n = 15	14	93
Easy lexical decision		
Words n = 25	23	92
Nonwords n = 25	22	88
Nonwords of different structure		
Type A n = 10	8	80
Type B n = 10	9	90
Type C n = 10	9	90
Type D n = 10	9	90
Type E n = 10	8	80
Type F n = 10	9	90
Type G n = 10	8	80

Table 4.7.10 READING ERRORS - WORDS

		Number of errors	Percentage of errors
Visual		11	5
Sharing initial letter(s) with stimulus	4		
Sharing init. & fin. letter(s) with stimulus	6		
Sharing final letter(s) with stimulus	1		
Derivational		3	1
Derivational or Inflectional (ing)		3	1
Inflectional		3	1
Function Word Substitutions		1	0
Phonemic paraphasia		124	58
Phonemic paraphasia or Visual		46	21
Other		24	11
Possibly visual, not satisfying criteria	1		
Completion	3		
Phonemic paraphasias or der.	1		
Phonemic paraphasia or regularisation/alternative realisation	5		
Literation	1		
Substitution, addition or deletion of word segments	6		
Incomplete	1		
Unclassified	6		
TOTAL ERRORS		215	
Words misread		209	24
Omissions		0	0
Words read correctly		679	76
TOTAL PRESENTED		888	
Error responses corrected		6	

Table 4.7.11 READING ERRORS NONWORDS

		Number of errors	Percentage of errors
Lexicalisations			
Visually similar to stimulus		118	54
sharing initial letter(s) with stimulus	92		
sharing init. & fin.letter(s) with stimulus	28		
sharing final letter(s) with stimulus	25		
sharing medial letter(s) with stimulus	35		
sharing letters not in corresponding posns.	4		
	26		
Visually distinct from stimulus			
sharing initial letter(s) with stimulus	26		
sharing final letter(s) with stimulus	6		
sharing letter(s) not in corresponding posns.	2		
sharing phoneme(s) but not letters with stimulus	8		
	10		
Incorrect nonwords			
mixed/multiple errors of grapheme-phoneme conversion		95	43
substitution, addition or omission of word segments	25		
phonemic realisation of silent _e_	6		
failure of marking function of silent _e_	2		
addition of single grapheme phoneme	1		
omission of single grapheme/phoneme	2		
substitution of single grapheme/phoneme	10		
	49		
Other			
Literation		7	3
	7		
TOTAL ERRORS		220	
Nonwords misread		214	60
Omissions		2	1
Nonwords read correctly		141	39
TOTAL PRESENTED		357	
Corrections			2
Additional errors due to multiple responses			4

Table 4.7.12 TEXT READING ERRORS

	Number of errors	Percentage of errors
Errors on stem of content words (n = 56)	7	13
Derivational/inflectional errors on content words	0	0
Errors on function words (n = 69)	3	4
TOTAL WORDS IN PASSAGE	125	

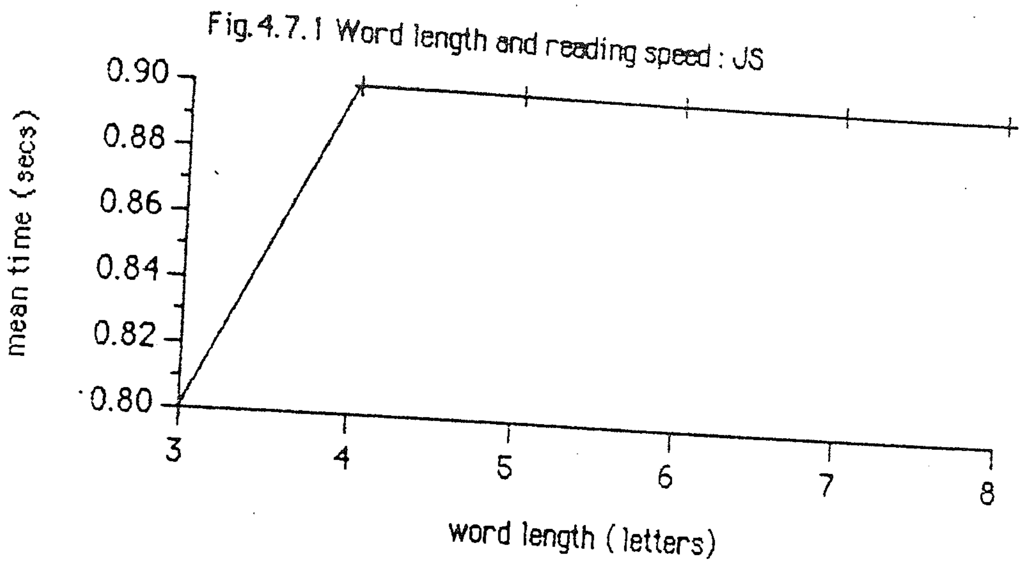


Fig. 4.7.1 Word length and reading speed : JS
0.90
0.88
0.86
0.84
0.82
0.80
mean time (secs)
3
4
5
6
7
8
word length (letters)

Fig. 4.7.2 Reading responses to words : JS

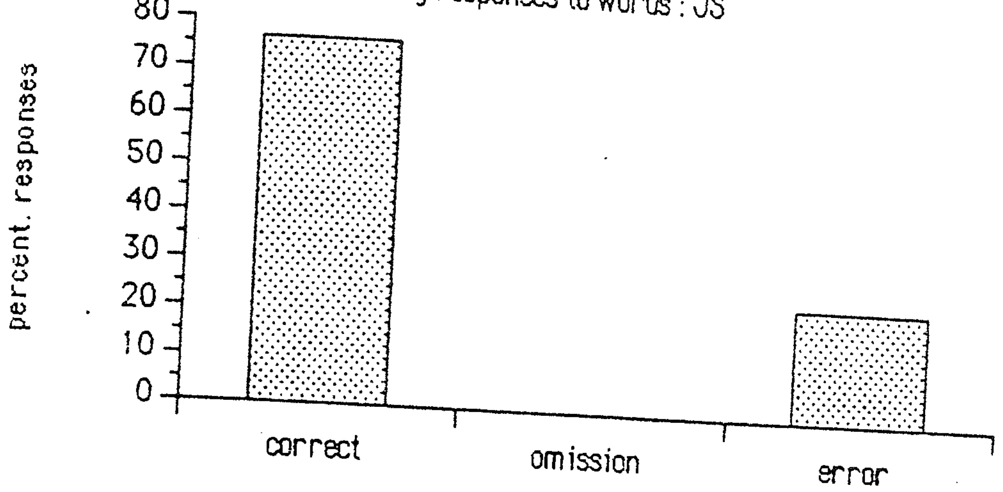


Fig. 4.7.3 Reading responses to nonwords : JS

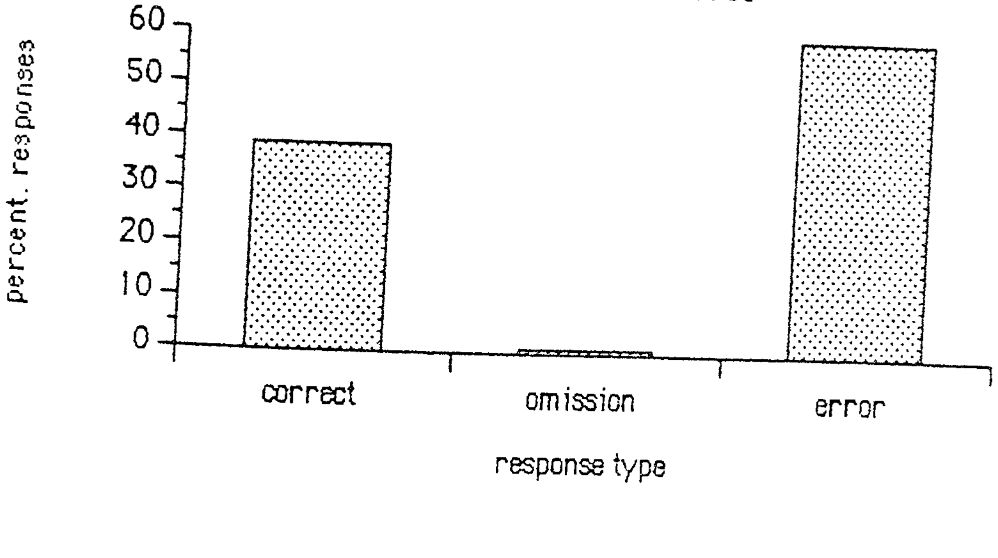


Fig. 4.7.4 Types of error response to words : JS

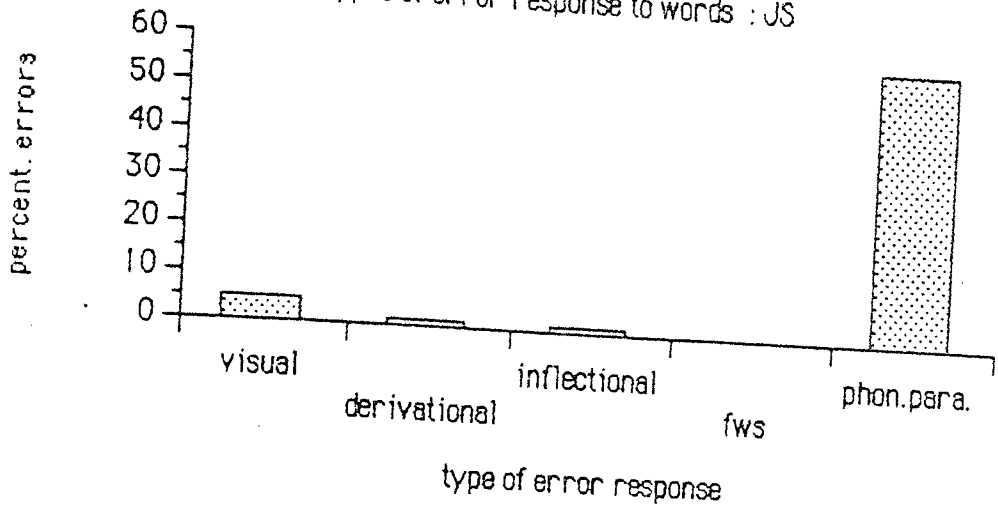
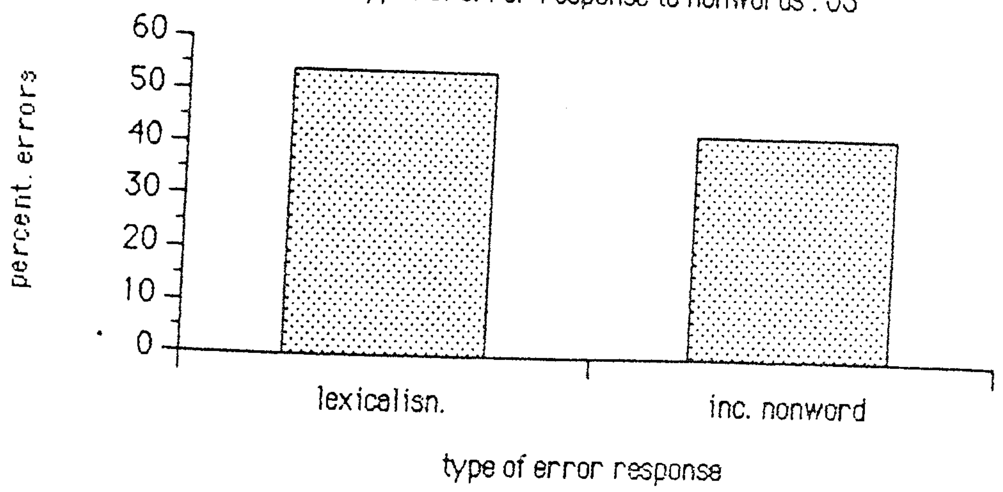


Fig. 4.7.5 Types of error response to nonwords : JS



4.7.6 Analysis of Test Results

4.7.6.1 Reading at the single word level

There is no significant effect on performance of varying imageability (Standard: X^2 (1df) = 2.1, P>.05; Difficult: X^2 1df) = .12, P>.05), Regularity of Spelling (Standard: (X^2 (1df) = .51, P>.05 and (second occasion) X^2 (1df) = .06, P>.05), Frequency (scores on high and low frequency items are equal), or Word Length (Reading accuracy = Kendall's S = 0, p>.05, Reading speed: Kendall's S = 10, P>.05). There is no effect of the presence of a suffix (I: scores on suffixed and unsuffixed are equal; II: X^2 (1df) = 2.2, P>.05). There is no effect of Part of Speech in the easy test (X^2 (3df) = 7.3*, P>.05). There is an effect of Part of Speech in the difficult test (X^2 (3df) = 9.6*, P<.05) in which function words are read better than other parts of speech. Performance is poor on both lexical decision tests (Easy: Hit rate = 1, False Alarm Rate = 1, d' = 0; Difficult: Hit Rate = .7, False Alarm Rate = .5, d' = .52).

4.7.6.2 Tests of comprehension and Morphological Knowledge

There is an effect of imageability in the Synonym Matching Task (X^2 (1df) = 5.7, P<.05). There is no effect of imageability when items in this test are read aloud (Z = 0, P>.05). JS's reading score is significantly higher than her matching score (X^2 (1df) = 12.9, P< .001). JS's score of 7/16 on the Semantic Probe Test is at chance (chance = 8($\pm$4)). In the Comprehension of Functors Test her score is significantly above chance (chance = 9($\pm$3)). Performance on the single word test of morphological knowledge is very poor, a Hit Rate of .3 and a False Alarm Rate of .4 yielding a d' of -.27.

4.7.6.3 Tests of nonword processing

Words are read better than nonwords in all tests (Easy Lexical Decision: X^2 (1df) = 5.3, $P<.05$; Difficult Lexical Decision = X^2 (1df) = 15, $P<.001$; Words and Nonwords of Different Structure: X^2 (1df) = 12.9, $P<.01$). There is no effect of the presence of an inconsistent letter (X^2 (1df) = 2.1, $P>.05$) or an inconsistent segment ($Z = .4$, $P>.05$). There is no significant effect of pseudohomophony (I = X^2 (1df) = 2.1, $P>.05$; II = X^2 (1df) = 3.2, $P>.05$). There is no effect of stimulus type in Reading by Analogy I ($Z = .7$, $P>.05$) or II ($Z = 0$, $P>.05$). There is no significant effect of the presence of a colour cue in the Nonwords Synthesised from Words Test ($Z = .9$, $p>.05$). There is no significant difference between scores on words and nonwords in the Sound Blending I Test ($Z = 1.2$, $P>.05$). In the Segmentable Words Test the score in the Visual Mode is significantly higher than the score in the auditory mode (X^2 (1df) = 10, $P<.01$). There is no overall effect of type of nonword in the Structured Nonwords Test (X^2 (7df) = 12.9, $P>.05$). There is a significant difference between scores on Type C and E and Type D and F nonwords, the total score on the former pair being 14/40 and on the latter pair 25/40 (X^2 (1df) = 6, $P<.05$). The score on the former pair is the only score which is significantly lower than the score on Type A items (X^2 (1df) = 4.9, $P<.05$). There is no significant difference between the score on Type A items and Type D and F items (X^2 (1df) = .03, $P>.05$), on Type A items and Type B and G items (X^2 (1df) = 1.2, $P>.05$) or on Type A items and Type H items (X^2 (1df) = 1.6, P>.05). There is no significant difference between scores on Type C and Type E items or between scores on Type B and Type G items (scores are identifical in both cases). There is however a significant difference between the score on Type D items and the score on Type F items (X^2 (1df) = 5.2, P<.05).

Low d' figures occur in all Silent Tests of Phonology (I, Nonword: Hit Rate = .8, False Alarm Rate = .6, d' = .58; I, Regular Word: Hit Rate = .8, False Alarm Rate = .6, d' = .58; I, Irregular Words: Hit Rate = .96, False Alarm Rate = .7, d' = 1.22 II: Hit Rate = .8, False Alarm Rate = .5, d' = .84).

4.7.6.4 **Tests of repetition ability**

There is no significant difference between repetition of words and nonwords (Pseudohomophony I: scores identical; Easy Lexical Decision: Z = 0, p>.05). There is no significant effect of type of nonword on the repetition of Structured Nonwords (X^2 (6df) = 1.4*, P .05).

4.7.6.5 **Reading errors: Words**

The highest proportion of errors (58%) are phonemic paraphasias. This category contains significantly more items than does the visual error category (X^2 (1df) = 94.6, P<.001). The derivational and inflectional error categories each contain the same number of items.

4.7.6.6 **Reading errors: Nonwords**

There is no significant difference between the number of lexicalisation errors and the number of errors which are incorrect nonwords (X^2 (1df) = 2.5, $P>.05$). Significantly more lexicalisation errors are visually similar to the stimulus than are visually distinct (X^2 (1df) = 36.9, $P<.001$).

4.7.6.7 **Reading errors: Text**

There is no significant difference between the number of errors made in response to content words and the number made in response to function words in reading the passage of text (Z = 1.3, $P>.05$).

4.7.7 Discussion of Reading Impairment

4.7.7.1 **Reliance on the direct route for reading aloud**

Evidence for reliance on the direct route is provided by the pattern of performance on the Synonym Matching Test. JS obtained a score of 67/76 (88%) when reading aloud items for this test but a significantly lower score (48/76, 63%) on the matching task. Furthermore, there is a significant effect of imageability (high-imageable better than low-imageable) in the matching task but no such effect in any reading task. Further evidence of comprehension impairment is provided by JS's score on the Semantic Probe Test which is at chance. It is implausible that JS uses the phonological route for reading aloud words in this test. She read, overall, only 39% of nonwords correctly and her score dropped to 10% when longer items (reading aloud difficult lexical decision) were presented.

4.7.7.2 Performance on Function Words

Part of Speech is the only variable which significantly affects JS's performance on reading aloud single words. Function words are read aloud better than other parts of speech. (This difference reaches significance in the difficult but not in the easy test; function words were 100% correct in both tests). In text reading fewer errors are made on function than on content words but this difference did not reach significance. The majority of JS's errors are phonemic paraphasias. These errors (see Chapter 3) are assumed to occur during articulation. They are observed in speech (see BDAE 2-score profile, Appendix I) and in repetition to a lesser degree. The almost total absence of such errors when articulating function words requires explanation.

In the easy Part of Speech Test, superior performance on function words could be due to frequency, although in this case, the lack of an effect in the Frequency Test, is unexpected. All items in this test are rated A or AA in the Thorndike Lorge count. However, as Ellis et al. (1983) point out, function words tend to be of higher frequency than content words within these high frequency bands. However, in the difficult Part of Speech Test, items are of lower frequency and are closely matched for frequency. A possible explanation is that the function words in this test are mainly composite and longer items contain shorter high frequency function words (e.g. <u>thereupon</u> = there

+ upon). IC (Case Report X who presented with a severe articulatory impairment was also more efficient at articulating function than content words.

JS's relatively unimpaired comprehension of functors is somewhat surprising. She obtained a score of 89% on the Comprehension of Functors Test, in spite of the comprehension impairment indicated by performance on the Semantic Probe and Synonym Matching Tests. Particularly relevant is the superiority of performance on high-imageable items which is evident in the latter test. Since function words tend to be low in imageability, good comprehension in this case suggests the possibility of a separate semantic store for functors. However, no such claim will be made on the basis of the limited evidence presented here.

4.7.7.3 **Morphological knowledge and morphological decomposition**

JS performed poorly on the test of morphological knowledge. She clearly does not understand the role of inflected forms as tense indicators. However, JS makes very few derivational/inflectional errors (errors of these types account for only 3% of total errors) and is unaffected by the presence of a suffix. It seems unlikely, therefore, that these represent true error categories. The errors assigned to these categories should probably be reclassified as visual errors. In the case of inflectional errors in which the error involves the addition of final "s", there is the posssibility of the errors being phonemic paraphasias.

The presence of true derivational/inflectional errors in a patient relying on the direct route for reading aloud single words would provide convincing evidence for a morpheme-based visual recognition system. In the absence of these errors, there is no reason to reject the model which posits a morphological decomposition system within the lexical-semantic route (see Chapter 1, Fig. 1.5).

JS's responses to inappropriately suffixed words, however, provide some support for Job and Sartori's (1984) claim that there are affix "input recognizers." In this case, where there is reliance on the direct route, these recognizers would be located within the visual word recognition system. JS read inappropriately suffixed items at a standard identical to that at which she read words (76% correct). Three of her 6 errors were phonemic paraphasias and the remaining 3 errors result from failure to blend stem and affix. When affixes were presented in isolation JS read 80% correctly. These scores are well above the overall score for nonword reading (39% correct) and suggest that affixes are not simply processed as nonwords by this patient. Since the ability to read affixes in isolation is not always preserved in phonological dyslexia, it must be assumed that if there is a store of affix recognisers this store can be selectively impaired.

4.7.7.4 Visual errors and phonemic paraphasias

JS makes very few visual errors, this category accounting for only 5% of total errors. The category may be somewhat larger since a number of errors in which a response differing from the target by a single phoneme formed a word (e.g. steak -> "lake"; move -> "mood") could have fallen into this category or into the phonemic paraphasia category. In a number of cases, the nature of the error was checked by asking JS to give the meaning of the word (which she was able to do by means of pantomime; she never gave any verbal definition). In spite of her comprehension difficulty she was able to indicate meanings on several occasions and in every case, the meaning was that of the original stimulus word, not of the error response. For instance, after reading <u>steak</u> as "lake" she mimed the action of eating with a knife and fork. In such cases, errors were classified as phonemic paraphasias. Where no intelligible response was made, errors remained in the Phonemic Paraphasia or Visual Category. The paraphasic errors, which occur at the articulatory stage, do not result from impairment within the direct route itself. This route functions very efficiently in this case. If phonemic paraphasias are reclassified as correct responses, JS's overall success rate on reading single words increases from 76% to 90% (96% if the phonemic paraphasia or visual category is counted as correct). The direct route thus processes at least 90% of single word stimuli accurately. The occasional visual errors can be explained in terms of difficulty in accessing visual word representations or in selecting the correct match from a range of activated representations (see Chapter 2).

The possibility of a consistent pattern appearing in phonemic paraphasias with certain phonemes being substituted repeatedly for others was considered. Such a pattern, if observed, would be helpful in distinguishing phonemic paraphasias from visual errors. The Regularity of Spelling Test was administered on 2 occasions in order to check for consistency. In fact, no consistent pattern was observed. There is no significant difference between overall scores on the test, but out of a total of 52 errors made on the two occasions, only 10 words were read erroneously on both occasions and only 1 word elicited the same erroneous response on both occasions.

4.7.7.5 Lexical decision tasks

Since at least 90% of items with which JS was presented were processed efficiently by the direct route, JS's poor lexical decision performance requires comment. In the easy test, Hit Rate is 1 and False Alarm Rate is 1; in the difficult test, Hit Rate is .7 and False Alarm Rate .5. The d' statistics obtained reflect (especially in the easy test) a tendency to accept all items as words rather than reject them incorrectly. Visual word representations may be activated on the basis of approximate visual information; and discrepancies of visual form may remain undetected when no exact match is activated; the low rate of visual errors suggests that an exact match is usually selected when available.

4.7.7.6 The nonword reading impairment

4.7.7.6.1 General Comments

JS's responses to nonwords, whether correct or incorrect, were produced rapidly and apparently effortlessly. She did not balk at nonwords as other patients reported in this work tended to do and when word and nonword items were intermixed showed no sign of recognising that an item was a nonword. Nevertheless, only 39% of nonwords as opposed to 76% of words were read correctly.

Errors on nonwords require careful interpretation in view of the frequency of phonemic paraphasic errors in word reading and speech. Certain lexicalisations (e.g. sheb -> "shed") could, in fact, be phonemic paraphasias. On certain occasions a check on the category was made by asking JS for the meaning of the word which she had pronounced. She did not show surprise at this request even when she had been told at the beginning of the test that items were nonwords. However the check was inconclusive since only 12 clear definitions of the response word were given. JS never produced verbal definitions but used pantomime to indicate meanings; the words which can be defined in this way are limited. Since these doubtful errors usually differ from the target in only one phoneme, the error responses could also have been produced through misconversion of a single grapheme. On the other hand, certain incorrect nonwords (and occasionally correct nonwords) could also result from phonemic paraphasia or from a lexicalisation followed by a phonemic paraphasia. It is possible that the latter error type might occur more frequently in articulating unfamiliar segments and thus explain the dissociation between word and nonword reading. If this were so, these errors should occur frequently in the repetition of nonwords. In fact, errors in repetition are few and there is no difference in performance on words and nonwords. Poor performance on Nonword Silent Test of Phonology also indicates that the problem is not primarily one of articulation.

4.7.7.6.2 The locus of impairment within the phonological route: nonwords of different structure test

JS reads correctly 51% of items in this test. The effect of stimulus type does not quite reach significance when all subtests are analysed. However, scores on Type C and Type E items are lower than scores on other items. The combined scores on these subtests are significantly lower than the score on Type A items and significantly lower than the combined scores on Type D and Type F items. No other type of item is read significantly worse than the Type A items (which provide the baseline measure). This pattern is compatible with a deficit in the Phoneme Allocation System. An aspect of the results which is difficult to explain is that Type D items are read significantly better than Type F items. The latter differ from the former only in stimulus length yet this variable does not appear to affect other subtest pairs. In fact, Type G items (which contain 4 phonemes) are read better than Types F, H, C and E items.

As noted in discussing CB's errors (Case Report IV) errors due to the misconversion of a single grapheme are compatible with the presence of an impairment in the Phoneme Allocation System. The majority (67%) of JS's errors which are classified as Incorrect Nonwords (but see earlier comment on classification difficulty) involve the substitution, addition or deletion of a single grapheme. This overall error pattern is observed in the Structured Nonwords Test, although the highest proportion of errors produced in response to Type C and Type E items are lexicalisations. These lexicalisations do not provide corroborative evidence for the hypothesised locus of impairment but neither do they argue against it, since it is possible that in many cases, the phonological route produces no output in response to items which require the use of an impaired processor. Of the responses to items containing inconsistent graphemes which are classified as incorrect nonwords, 33% involve misconversion of the digraph, 44% involve misconversion of another grapheme, and 22% involve misconversion of the digraph and an additional grapheme.

4.7.7.6.3 The locus of impairment within the phonological route: additional evidence

47.7.6.3.1 Nonwords with inconsistent letters

If the Phoneme Allocation System is the locus of impairment within the phonological route, nonwords without inconsistent letters should be read more efficiently than nonwords with inconsistent letters. This is the case - JS read 28% of the former and 14% of the latter. However this difference does not reach significance and does not therefore provide additional evidence for the hypothesised locus of impairment.

4.7.7.6.3.2 Single letter processing

JS gave only 1 correct phoneme in response to a visually-presented letter (1/24, 4% correct). This inability to give letter sounds is compatible with an impairment in the Phoneme Allocation System although as noted in earlier discussion, this ability can dissociate from nonword reading ability. There is evidence of some impairment in the Abstract Letter Recognition System - JS obtained a score of 83% on the Cross-case Letter Matching Task and was somewhat impaired in her ability to name single letters (69% when presented in isolation, 80% when presented in a string.

4.7.7.6.3.3 The Resegmentation System

In spite of relatively good performance on structured nonwords containing a consonant unit, JS's performance on segmentation tests which do not involve the reading aloud of nonwords suggest some impairment of the ability to segment visually-presented letter strings. She was unable to find words hidden in a nonword letter string efficiently (Hidden Words Test 30%. correct). Performance was somewhat better in the Visual Version of the Segmentable Words Test (80% correct). The score of 40% on the auditory version, which is signficantly lower than the score on the visual version indicates that the score on the latter was not obtained via the use of an auditory segmentation strategy.

4.7.7.6.3.4 The Blender

Performance on auditory sound blending tests shows evidence of impairment whether items to be blended are words or nonwords (words = 46%; nonwords = 29% and 13%). There is no significant difference between performance on words and nonwords. Scores on the Nonwords synthesised from Words Test are also low and the presence of a colour cue does not facilitate performance (with colour cue = 20% correct, without colour cue = 50% correct).

4.7.9 Summary and Conclusions

JS presents with a phonological dyslexia in which nonword reading is severely impaired but not totally abolished. There is evidence of a comprehension deficit and it is concluded that JS relies on the direct route for reading words aloud. There is evidence from the Structured Nonwords Test that the major impairment within the phonological route is in the Phoneme Allocation System. Additional test results suggest less severe impairment of other subsystems. The predicted effect of the presence of an inconsistent letter occurs, although differences in scores do not reach significance. JS's errors which frequently involve the mosconversion of a single grapheme tend to support the hypothesised locus of impairment. It is concluded that each subsystem within the phonological route is impaired to some extent but that the major impairment is in the Phoneme Allocation System.

Notes for Case Report V

1 An investigation of JS's tendency to correct morphological errors in reading aloud sentences was undertaken in addition to these tests. This investigation is reported elsewhere (Bradley, 1984) and will not be discussed here because of shortage of space.

4.8 Case Report VI: ZS

4.8.1 Neurological Background

ZS is a 63-year old right-handed man who sustained a CVA in the summer of 1982. He was admitted to Burton Road Hospital with aphasia and right hemiplegia. No information regarding site of lesion is available. The hemiphlegia has now resolved and ZS writes with his preferred right hand. A fluent aphasia persists.

4.8.2 Eductional and Occupational Background

ZS was educated in Poland. He received 9 years schooling and at the age of 16 joined the Polish Air Force as a trainee pilot. He completed his training as a pilot and came to England in 1942 where he joined a Polish squadron in the RAF. After the war he remained in England, employed as a grinder and stamper in an engineering firm. He became a fluent speaker of English and had no difficulty in reading English newspapers, books and training manuals.

4.8.3 Aphasia and Dysgraphia

ZS is now able to cope with conversation on everyday matters and has been discharged by his Speech Therapist. A mild anomia is present even in everday speech. Attempts to converse at a higher level normally fail and ZS's wife reports that he becomes very frustrated at his inability to express more complex ideas. The following example of spontaneous speech was elicited by a request to describe the "Cookie Theft" picture from the BDAE.

"The missus wiping the stuff, the dishes. The water's overflowing. One chap got to have some cookies but he falling over. A girl wanting some cookies. According to here on the deck is some cups and saucers. On the curtain and on here. That's it. The garden looks very nice and the open, the window is open."

Melodic line runs through the entire sentence and phrase length is not curtailed. There is slight impairment of articulatory agility. Auditory comprehension is well above the mean. Repetition is unimpaired at the single word level but somewhat impaired at the phrase level (4/8 on high probability and 6/8 on low probability subtests). Reading comprehension is above average with the exception of comprehension of oral spelling (2/8). Performance is above average, though impaired, on responsive naming (26/30), confrontation naming (86/105), animal naming (7/23) and body part naming (26/30). A copy of the BDAE Z-score profile is provided in Appendix I.

ZS has a severe written spelling difficulty. He wrote correctly to dictation only 5/22 words. He has never been very good at English Spelling, however, and his post-morbid spelling is not discussed further for this reason.

4.8.4 A note on accent

ZS's wife and family report that he spoke English with very little trace of a foreign accent prior to his CVA. His Polish accent returned following the CVA. The following charateristics of the accent have been noted and care has been taken in analysing reading responses to ensure that distortions due to accent are not counted as errors. Information on the Polish alphabet is taken from Knowles & Hobbs (1972).

i) Word final /d/ is often, though not always realised as /t/. This is especially true if it occurs in a consonant cluster (e.g. found → /faʊnt/, but bed → /bɛd/.

ii) /θ/ and /ð/ are normally pronounced /t/. There is no /θ/ or /ð/ sound in the Polish Alphabet.

iii) /ʌ/ tends to be pronounced /ɒ/. This is not always the case, however, and there is no difficulty in eliciting the /ʌ/ sound in repetition tasks.

iv) Word-initial /w/ is often pronounced /v/. There is no /w/ in the Polish Alphabet and the letter w is normally realised as /v/.

4.8.5 Neuropsychological Baseline Tests

ZS obtained a Memory Quotient of 83 on the Wechsler Memory Scale. He has a digit span of 6 forward and 3 backward. A score of 23.5/36 on the Token Test indicates a moderate impairment of auditory comprehension. He obtained an I.Q. quivalent of 73 on the Spoken Version and 92 on the Written Version of the PPVT. He scored 16/60 on the extended Boston Naming Test. This score is compatible with the presence of anomic aphasia.

4.8.6 Reading and repetition tests

The results of reading and repetition tests are shown in Tables 4.8.1 to 4.8.9. A transcription of ZS's reading of the passage of text is provided in Appendix II. Error types are shown in Tables 4.8.10 to 4.8.12. Figure 4.8.1 shows the effect of word length on reading speed. Proportions of errors falling into the main error categories and proportions of different types of error response are shown in Figures 4.8.2 to 4.8.5.

Table 4.8.1 READING AT THE SINGLE LETTER LEVEL

Number Test		Correct	Percentage Correct
Single letter naming	n = 26	24	92
Single letter sounding	n = 24	1	4
Single letters from a string	n = 20	19	95
Cross-case letter matching	n = 58	56	97

Table 4.8.2 READING AT THE SINGLE WORD LEVEL

Test	Number Correct	Percentage Correct	Significant effect of Variable
Easy lexical decision n = 50	43	86	
Difficult lexical decision n = 40	27	68	
Imageability (standard)			
High Imageable n = 20	18	90	-
Low Imageable n = 20	14	70	
Imageability (difficult)			
High Imageable n = 20	14	70	+
Low Imageable n = 20	6	30	
Part of speech (easy)			
Noun n = 20	19	95	-
Verb n = 20	20	100	
Adjective n = 20	20	100	
Function word n = 20	18	90	
Part of Speech (difficult)			
Noun n = 20	14	70	-
Verb n = 20	13	65	
Adjective n = 20	8	40	
Function word n = 20	8	40	
Part of speech (revised)			
Noun n = 25	24	96	-
Verb n = 23	19	83	
Adjective n = 25	23	92	
Function word n = 37	34	92	
Regularity of spelling (standard)			
Regular n = 39	30	77	-
Irregular n = 39	27	69	
Frequency			
High Frequency n = 23	21	91	-
Low Frequency n = 23	18	78	
Word length			
3-letter n = 10	10	100	-
4-letter n = 10	9	90	
5-letter n = 10	9	90	
6-letter n = 10	10	100	
7-letter n = 10	9	90	
8-letter n = 10	8	80	
Presence of Suffix I			
Suffixed n = 30	25	83	-
Unsuffixed n = 30	20	67	
Presence of Suffix II			
Suffixed n = 28	13	46	-
Unsuffixed n = 28	8	29	

Table 4.8.3 COMPREHENSION TESTS

Test	Number correct	Percentage correct
Synonym matching		
High Imageable n = 38	32	84
Low Imageable n = 38	24	63
Semantic Probe n = 16	12	75
Comprehension of functors n = 18	17	94

Table 4.8.4 TEST OF MORPHOLOGICAL KNOWLEDGE

Test	Number correct	Percentage correct
Single word test n = 32	18	57

Table 4.8.5 TESTS OF NONWORD PROCESSING

Test	Number correct	Percentage correct	Significant effect of Variable
Reading aloud			
Easy Lexical Decision			
Words n = 25	25	100	+
Nonwords n = 25	3	12	
Nonwords with inconsistent letters			
With inconsistent letter n = 18	0	0	-
Without inconsistent letter n= 18	0	0	
Nonwords synthesised from words			
with colour cue n = 10	1	10	-
without colour cue n = 10	1	10	
Segmentable words			
Visual mode n = 30	27	90	+
Auditory mode n = 30	12	40	
Hidden words n = 20	0	0	
Sound Blending I			
Words n = 24	10	42	-
Nonwords n = 8	1	13	
Sound Blending II n = 35	5	14	
Consistent and Inconsistent nonwords			
With consistent segment n = 15	1	7	-
With inconsistent segment n = 15	2	13	
Reading by analogy I: Deletion			
Type A nonwords n = 15	0	0	-
Type B nonwords n = 19	0	0	
Reading by analogy II: Substitution			
Type A nonwords n = 13	0	0	-
Type B nonwords n = 13	0	0	
Pseudohomophony I			
Pseudohomophones n = 15	5	33	-
Non-pseudohomophones n = 15	4	27	
Pseudohomophony II			
Pseudohomophones n = 10	4	40	-
Non-pseudohomophones n = 10	0	0	
Inappropriately suffixed nonwords n = 25	6	24	
Affixes in isolation n = 10	1	10	

Table 4.8.6 READING ALOUD NONWORDS OF DIFFERENT STRUCTURE

Type	Example	Number of correct	Percentage correct
A	tad	5	25
B	ank	1	5
C	ead	2	10
D	eth	8	40
E	tood	2	10
F	dack	9	45
G	dunt	4	20
H	afe	5	25

n = 20 in each list

Table 4.8.7 READING ALOUD WORDS AND NONWORDS OF DIFFERENT STRUCTURE

Type	Percentage of words correct	Percentage of nonwords correct
A	100	30
E	80	20
F	90	30
G	90	20

n = 10 in each list

Table 4.8.8 SILENT TESTS OF PHONOLOGY

Test	Number correct	Percentage correct
Silent test of phonology I		
Nonword n = 50	28	56
Regular word n = 50	29	58
Irregular word n = 50	22	44
Silent test of phonology II n = 40	24	60

Table 4.8.9 TESTS OF REPETITION ABILITY

Test	Number correct	Percentage correct
Pseudohomophony I		
Words n = 15	9	60
Nonwords n = 15	12	80
Easy lexical decision		
Words n = 25	25	100
Nonwords n = 25	23	92
Nonwords of different structure		
Type A n = 10	7	70
Type B n = 10	7	70
Type C n = 10	6	60
Type D n = 10	7	70
Type E n = 10	7	70
Type F n = 10	8	80
Type G n = 10	9	90

Table 4.8.10 READING ERRORS - WORDS

		Number of errors	Percentage of errors
Visual		79	40
Sharing initial letter(s) with stimulus	39		
Sharing init. & fin. letter(s) with stimulus	29		
Sharing final letter(s) with stimulus	8		
Sharing medial letter(s) with stimulus	1		
Sharing letter(s) not in corresponding psns.	2		
Derivational		16	8
Inflectional		20	10
Nouns	4		
Verbs	14		
Adjectives	2		
Function Word Substitutions		6	3
Substitution, omission or deletion of word segments		36	18
Other		42	21
Possibly visual, not satisfying criteria	2		
Completion	2		
Phonemic paraphasias	11		
Blending	1		
Regularisation	2		
Regularisation or visual	1		
Attempts to read via sub-lexical g-p-c	10		
Complex function word substitution	3		
Bizarre	10		
TOTAL ERRORS		199	
Words misread		183	22
Omissions		5	1
Words read correctly		652	78
TOTAL PRESENTED		840	
Error responses corrected		3	
Additional errors due to multiple attempts		13	

Table 4.8.11 READING ERRORS NONWORDS

	Number of errors	Percentage of errors
Lexicalisations		
Visually similar to stimulus 135	170	69
sharing initial letter(s) with stimulus 67		
sharing init. & fin.letter(s) with stimulus 39		
sharing final letter(s) with stimulus 24		
sharing letters not in corresponding posns. 5		
Visually distinct from stimulus 35		
sharing initial letter(s) with stimulus 15		
sharing final letter(s) with stimulus 8		
sharing mediallletter(s) with stimulus 4		
sharing letter(s) not in corresponding posns 6		
sharing no letters or phonemes with stimulus 2		
Incorrect nonwords	73	30
mixed/multiple errors of grapheme-phoneme conversion 45		
phonemic realisation of silent _e_ 2		
failure of marking function of silent _e_ 2		
addition of single grapheme phoneme 7		
substitution of single grapheme/phoneme 17		
Other	2	1
Perseveration 1		
Literation 1		
TOTAL ERRORS	245	
Nonwords misread	237	70
Omissions	45	13
Nonwords read correctly	55	16
TOTAL PRESENTED	337	
Corrections	2	
Additional errors due to multiple responses	6	

Table 4.8.12 TEXT READING ERRORS

	Number Correct	Percentage Correct
Errors on stem of content words (n = 56)	5	9
Derivational/inflectional errors on content words	2	4
Errors on function words (n = 69)	11	16
TOTAL WORDS IN PASSAGE	125	

Fig. 4.8.1 Word length and reading speed : ZS

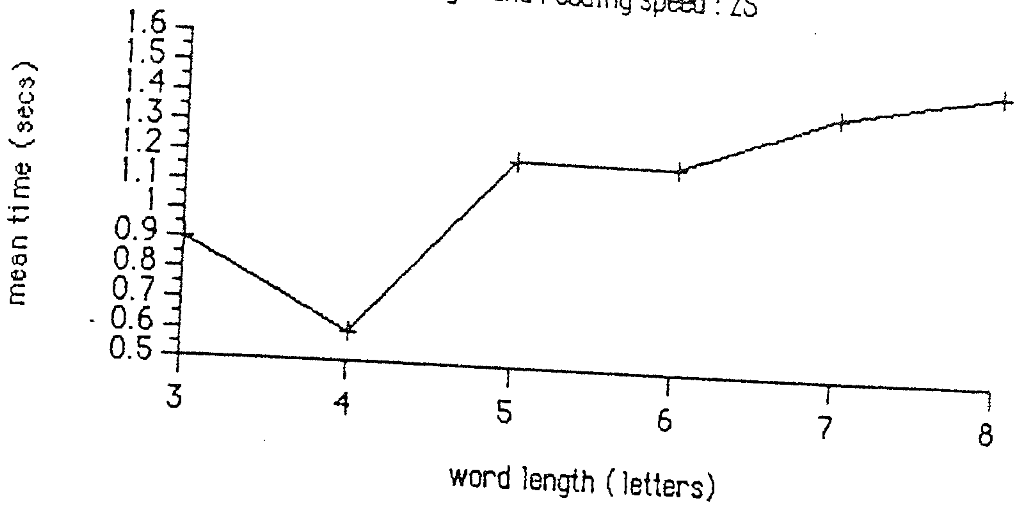


Fig. 4.8.2 Reading responses to words : ZS

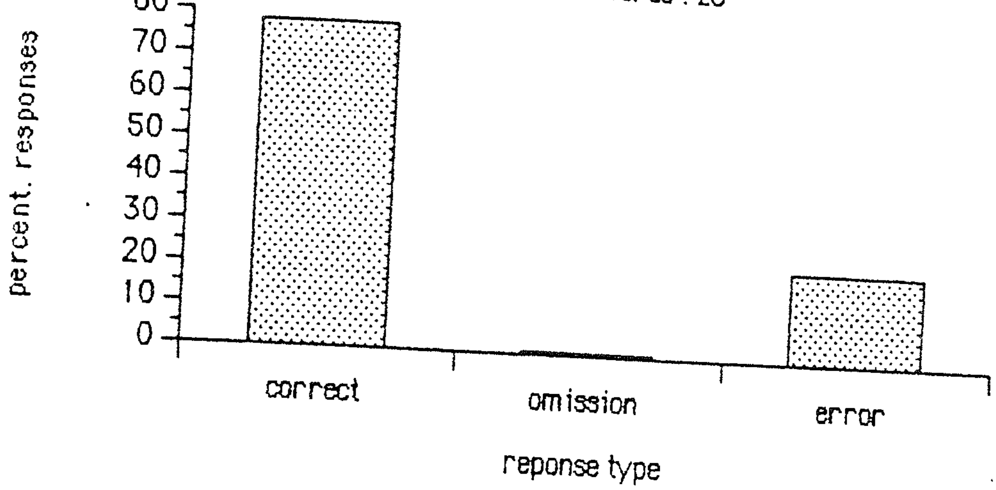


Fig. 4.8.3 Reading responses to nonwords : ZS

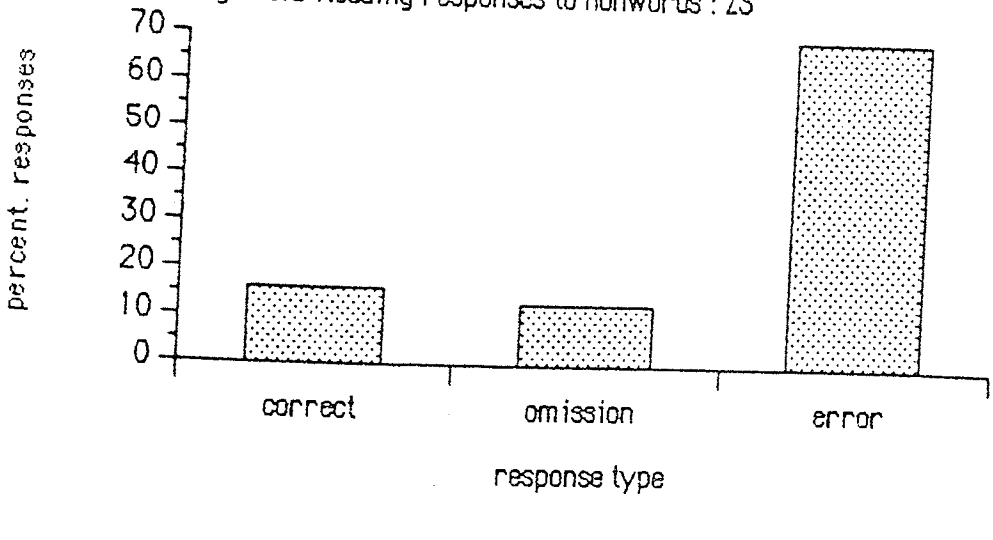


Fig. 4.8.4 Types of error response to words : ZS

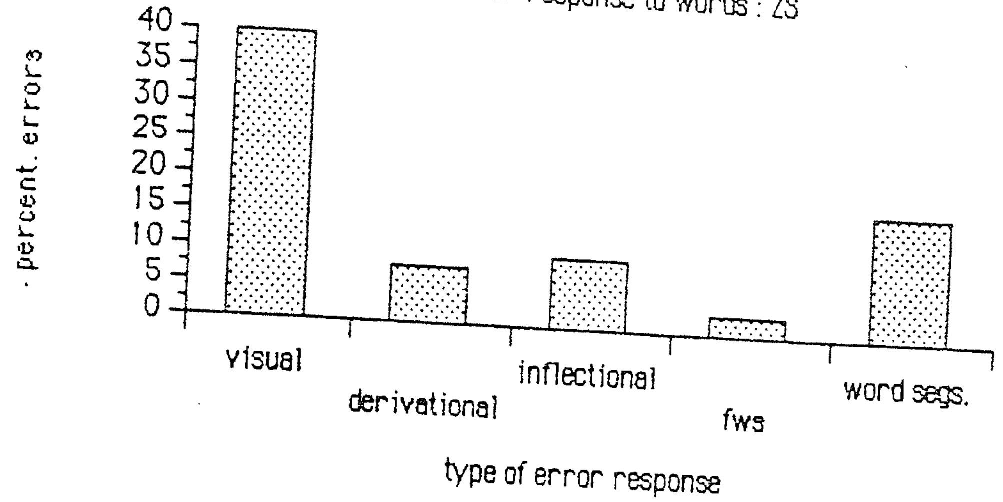
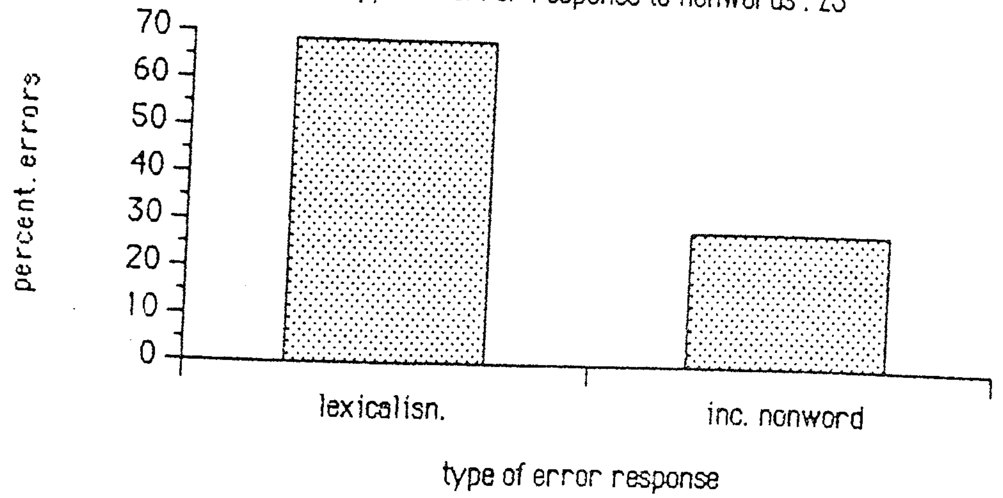


Fig. 4.8.5 Types of error response to nonwords : ZS



4.8.7 Analysis of Test Results

4.8.7.1 Reading at the single word level

There is no significant effect on performance of varying Part of Speech (Easy: scores too high to allow accurate statistical analysis; Difficult: (X^2 (3df) = 6.2, P>.05); Revised: X^2 (3df) = 3, P>.05), Regularity of Spelling (X^2 (1df) = .59, P>.05); Frequency (Z = .8, P> .05), or Word Length (Accuracy: Kendall's S = 7, P> .05; Time: Kendall's S = 10, P>.05). There is no effect of the Presence of a Suffix (I = X^2 (1df) = 2.2, P>.05); II: = X^2 (1df) = 1.9, P>.05). In the standard Imageability Test the difference between high and low-imageable scores does not reach significance. There is a significant effect of Imageability in the difficult test (X^2 (1df) = 6.4, P< .05). Lexical decision performance is poorer in the Difficult than in the Easy Test (Easy: Hit Rate = 1, False Alarm Rate = .3, d' = 2.84; Difficult: Hit Rate = .6, False Alarm Rate = .3, d' = .78).

4.8.7.2 Tests of comprehension and morphological knowledge

There is a significant effect of Imageability in the Synonym Matching Task in which performance on high-imageable items is better than on low-imageable items (X^2 (1df) = 4.3, P<.05). This effect is also present in the reading aloud of items from this test (X^2 (1df) = 9.8, P<.01). There is no difference between performance levels in reading and matching tasks (total scores are identical). ZS's score of 12/16 on the Semantic Probe Test is significantly above chance (Chance = 8 (±4). In the Comprehension of Functors Test his score is significantly above chance (Chance = 9 ($\pm$3). Performance on the single word test of morphological knowledge is very poor, a Hit Rate of .6 and a False Alarm Rate of .4 yielding a d' of .51.

4.8.7.3 Tests of nonword processing

Words are read better than Nonwords in the Reading Aloud Easy Lexical Decision Test (X^2 (1df) = 39.3, $P<.001$) and the Words and Nonwords of Different Structure Test (X^2 (1df) = 34.6, $P<.001$). There is no significant effect of the present of an inconsistent letter (zero scores on both types of item) or of the presence of an inconsistent segment ($Z = 0$, $P>.05$). There is no effect of Pseudohomophony (I: $Z = 0$, $P>.05$; II: $Z = 1.63$, $P>.05$). Scores in both Reading by Analogy Tests are zero. In the Nonwords Synthesised from Words Test, scores are identical on items with and without colour cue. There is no significant difference between performance on word and nonword items in the Sound Blending I Test ($Z = 1.1$, $P>.05$). In the Segmentable Words Test, the score in the Visual Version is significantly higher than the score in the Auditory Version (X^2 (1df) = 16.5, $P<.001$). There is a significant effect of type of item in the Structured Nonwords Test (X^2 (7df) = 17.5, $P<.05$). Type D and F nonwords are read significantly better than Type C and E nonwords (X^2 (1df) = 10.9, $P<.001$) and than Type B and G nonwords (X^2 (1df) = 9, $P<.01$), although the score on Type B and G nonwords does not differ significantly from the score on Type A nonwords(X^2 (1df) = 1.6, $P>.05$). Performance was poor on all Silent Tests of Phonology (I, Nonword: Hit Rate = .5, False Alarm Rate = .4, d' = .26; Regular Word: Hit Rate = .5, False Alarm Rate = .4, d' = .26; Irregular Word: Hit Rate = .5, False Alarm

Rate = .6, d' = -.26; II: Hit Rate = .6, False Alarm Rate = .4, d' = .51).

4.8.7.4 Tests of repetition ability

There is no significant difference between repetition of words and nonwords (Pseudohomophony I: $Z = .79$, $P > .05$; Easy Lexical Decision: $Z = .7$, $P > .05$). There is no effect of type of nonword on the repetition of Structured Nonwords (X^2 (6df) = 2.8*, $P > .05$).

4.8.7.5 Reading errors: Words

The highest proportion of errors (40%) are visual. This category contains significantly more errors than does the substitution, omission, deletion of word segments category or the combined derivational/ inflectional categories (X^2 (1df) = 16, $P < .001$ in each case). There is no significant difference between the number of errors in the derivational and the number in the inflectional category (X^2 (1df) = .44, $P > .05$).

4.8.7.6 Reading errors: Nonwords

There are significantly more lexicalisation errors than errors classifed as incorrect nonwords (X^2 (1df) = 38.7, $P < .001$). Significantly more lexicalisation errors are visually similar to the stimulus than are visually distinct (X^2 (1df) = 58.8, $P < .001$).

4.8.7.7 Reading errors: Text

There is no significant difference between the number of errors made on the stems of content words and the number of errors made on function words in reading the passage of text (X^2 (1df) = 1.4, P .05).

4.8.8 Discussion of Reading Impairment

4.8.8.1 Reliance on the lexical semantic route for reading aloud

There is no evidence to suggest that ZS is able to use the direct route when reading words aloud. Performance in the comprehension task in the synonym matching test is at the same level as performance in the reading test. Furthermore there is an effect of imageability (performance on high-imageable being better than performance on low-imageable items) in both tests. This effect is also observable in the difficult Imageability Test but differences in scores on the Easy Imageability Test, though in the expected direction, do not reach significance. The presence of an imageability effect in reading aloud tends to indicate reliance on the lexical-semantic route, since there is no reason why a semantic variable should affect reading performance when the direct route is in use.

4.8.8.2 The absence of Part of Speech effect

Since ZS relies on the lexical-semantic route for reading aloud, the absence of a Part of Speech effect and, in particular the absence of a function word deficit is of interest. There are few function word substitutions in ZS's error corpus (these account for only 3% of total errors) and all are visually similar to the stimulus. Thus it is likely that these errors are in fact visual. There is no evidence of serious comprehension impairment where the highly meaningful function words in the Comprehension of Functors Test is concerned. ZS scored 17/18 (94%) on this test. There is no evidence of Function Word deficit in ZS's reading of the passage of text. This case, like CB (Case Report IV) appears to demonstrate that reliance on the lexical-semantic route does not necessarily predict poor performance on function words. However, as noted in Case Report IV (Section 4.6.7.1.3) the ability to make some minimal use of the phonological route may compensate for the inefficiency of the lexical-semantic route in dealing with grammatical morphemes.

4.8.8.3 **Derivational and Inflectional errors**

These categories account for 18% of total errors. Since there is no significant effect of a suffix on reading performance and no difference between the percentage of errors in the inflectional and the percentage in the derivational category, there is reason to doubt whether these are genuine categories of error. ZS shows no improvement in nonword reading performance when stimuli are affixes in isolation (10% correct) or inappropriately suffixed nonwords (24% correct). In the latter test, the majority of error responses do not involve deletion or substitution of the affix (cf. CB, Case Report IV, Section 4.6.7.1.4) but involve substitution of the stem for a visually close word. In some cases, the affix is also substituted (e.g. <u>firster</u> -> freshest) in others the affix is retained (e.g. <u>thinging</u> ->

thinking). Of the error responses in this test 68% are lexicalisations, 21% involve substitution or deletion of the affix and 79% involve alterations to the stem. The frequency of this latter type of error, in conjunction with an inability to read affixes in isolation suggests that the Morphological Decomposition System may not be operative in this patient. The stimuli in this test appear to be processed as wholes. If the Morphological Decomposition System were functional and stimuli were parsed into stem and affix errors should occur on the affix rather than the stem. ZS's reading of affixes in isolation is very poor (10% correct) while his reading of high frequency words similar to those which form the stems of the inappropriately suffixed words is only mildy impaired (e.g. 91% correct in the Revised Part of Speech Test). This account is supported by the observation that lexical decision performance did not become less efficient when stimuli were affixed. When ZS was presented with a lexical decision test containing items from the inappropriately suffixed nonwords test matched with appropriately suffixed items, his score was 88% correct (Hit Rate = 1, False Alarm Rate = .2, d' = 3.16). The figure obtained for d' is in fact slightly larger in this test than in the Easy Lexical Decision Test.

This failure to parse affixed words may be unconnected with the acquired cerebral damage in this case. It may be associated with the fact that ZS is not a native speaker of English.

4.8.8.4 The Nonword Reading Impairment

4.8.8.4.1 The dissociation between word and nonword reading in Polish

The presence of phonological dyslexia when reading English stimuli is indicated by the dissociation between ZS's word reading (overall 78% correct) and nonword reading (overall 16% correct) abilities. The possibility that the deficit in nonword reading in English was due to the manner of acquisition of English as a second language was considered. If, written words, spoken words and their meanings were learned logographically, knowledge of grapheme-phoneme correspondences might never have been acquired. There is no reason to suppose that the acquisition of Polish would not utilise knowledge of grapheme-phoneme correspondences, however. Polish is an alphabetic language, although, like English, there is not always a one-to-one relationship between letters and phonemes (Schenker, 1973). In order to establish whether the phonological route could be used for processing Polish stimuli, ZS was asked to give names and sounds of letters in the Polish alphabet and to perform a lexical decision task and read aloud a set of Polish words and nonwords. Polish words were 20 nouns of 3-5 letters in length. Nonwords were formed by altering one letter of each word. The Polish alphabet (see Appendix IV) uses 23 letters of the mediaeval English alphabet and is enlarged to contain 32 individual symbols by the use of diacritics (Schenker, 1973). Vowels without diacritics have no name other than their phonemic realisation and these were not tested. Of the remaining letters ZS named 18/25 and gave sounds for 2/25. He made correct lexical decision judgements on words and nonwords on 26/40 (65%) occasions, (Hit Rate = .6, False Alarm Rate = .3, d' = .78. His reading of words and nonwords is shown in Table 4.8.13. Significantly more words than nonwords were read correctly (χ^2 (1df) = 10.1, P .01).

ZS shows evidence of impairment of the phonological route in both Polish and English.

Table 4.8.13 Polish Words/Nonwords Test

English Translation of Word	Words		Nonwords		
cavern	jama	+	łaswa	/woɷtə/	
strength	siła	+	tos	/sɔdʒə/	
goat	koza	+	elga	+	
years	lat	–	mieś	+	
torment	męka	/maɪ'ʃɛnskə/	fiła	/vivə/, no	
grace	łaska	+	koba	+	
fate	los	+	dat	+	
groats	krupa	+	dasek	/dɛskə/	±
faith	wiara	+	żit	/ʃuwə/	
relief	ulga	/ulə/	zęk	/zutə/	
roof	dach	+	bech	/bitʃ/	±
flour	mąka	+	raska	/rasə/	±
bow	łęk	/wikə/	żach	/ʒa/l/ʒi/	
subject	fach	+	jaba	/tʃeɪ/, /dʒætʃ/	
village	wieś	+	tęka	/rɪŋka/	
thong	pasek	+	giara	/ɪ'graveɪ/	
myth	mit	/mɪnt/,/mɪn'trældoɷ/	zrupa	"no I can't say"	
stick	laska	/læsə/	sach	/zaχə/ no	
moss	mech	+	hąka	–	
fear	lęj	+	nęk	–	
	14		4		

± - response is a Polish word

4.8.8.4.2 The locus of impairment within the phonological route: nonwords of different structure test

ZS read correctly 23% of items in this test. There is a significant effect of type of nonword. The pattern of scores is compatible with a deficit in the Phoneme Allocation System. Type D and Type F nonwords which contain a consonant unit are read significantly better than are Type C or Type E nonwords which contain a vowel digraph. Type D and Type F nonwords are also read significantly better than Type B and G nonwords which contain consonant clusters. This difference suggests an additional deficit in the Blender. The majority (70%) of errors on this test (including multiple responses) are lexicalisations. Of these lexicalisations 61% differ from the stimulus by one grapheme only and could possibly have been produced as a result of misconversion of a grapheme within the phonological route. Of the errors which are incorrect nonwords 61% differ from the target in only one grapheme/phoneme. Omissions account for 13% of error responses in this test. The error involves the vowel digraph in 60% of cases (e.g. eem -→/εm/) and another grapheme in 40% cases; when the stimulus and response differ in more than one grapheme the digraph is involved in each case. Error responses to items containing a consonant cluster are mainly lexicalisations (71%), with incorrect nonwords accounting for 21% of errors and omissions for 5%. Of the Incorrect Nonwords 56% involve the reduction of the consonant cluster to a single, often erroneous, grapheme (e.g. alb -→ / æp/) or vowel insertion and/or reordering of graphemes in such a way that the cluster is not pronounced (e.g. esk -→ / εkeɪ/; elb -→ / εbə /). As in the case of CB (Case Report IV) and JS (Case Report V) the pattern of errors does not provide strong additional evidence for the hypothesised loci of impairment but is compatible with these loci of impairment.

4.8.8.4.3 The locus of impairment within the phonological route: additional evidence

4.8.8.4.3.1 Nonwords with inconsistent letters

If the Phoneme Allocation System is the locus of impairment within the phonological route, nonwords without inconsistent letters should be read more efficiently than nonwords with inconsistent letters. ZS did not read any of the stimuli in this test correctly and results do not, therefore, provide additional evidence for the hypothesised locus of impairment.

4.8.8.4.3.2 Single letter processing

ZS gave only 1 correct phoneme in response to a visually-presented letter (1/24, 4% correct). This inability to give letter sounds is compatible with an impairment in the Phoneme Allocation System although as noted in earlier discussion, this ability can dissociate from nonword reading ability. There is no evidence of impairment in the Abstract Letter Recognition System - ZS obtained a score of 97% correct on the Cross-Case Letter Matching Task and was able to name letters accurately (92% when presented in isolation, 95% when presented in a string).

4.8.8.4.3.3 The Resegmentation System

ZS performed relatively well on nonwords containing a consonant unit and on the Visual Segmentable Words Test (90% correct). The latter score was not obtained via the use of an auditory segmention strategy since the score of 40% correct in the auditory version of this test is significantly lower than the score in the visual version. By contrast ZS obtained a zero score on the Hidden Words Test. As noted in the description of this test (Chap. 3, Section 1.5.6) there is no certainty that the resegmentation system within the phonological route is involved in this task and the dissociation between the ability to perform this task and the ability to read nonwords which require resegmention is explicable. The score is, however, surprisingly low in view of the high score on the Segmentable Words Test. The segmentation operation involved in the latter task is somewhat simpler than that involved in the Hidden Words Task as only a single left to right parse is required.

4.8.8.4.3.4 The Blender

Performance in the structured nonwords test suggests that there is some impairment of this subsystem. Performance on additional tests of blending ability is also poor whether items to be blended are words or nonwords (Words: 42% correct; Nonwords: 31% and 3% correct). There is no significant difference between performance on words and nonwords. Scores on the Nonwords Synthesised from Words Test are also very low and the presence of a colour cue does not facilitate performance (10% correct with or without colour cue).

4.8.8.4.3.5 A note on the construction of nonword stimuli and the analysis of errors in a bilingual subject.

When a subject is bilingual, it is possible that the stimuli which are nonwords in English in fact are words in the subject's native language. All nonword stimuli were therefore checked to ascertain whether they were spelled like or were homophonic with Polish Words. Very few stimuli do form Polish words. In the Easy Lexical Decision Test there are 2 such items (balt, meaning a Balt and farl - the genitive plural of a word meaning a radio wave). ZS read the first but not the second of these items correctly. In the Pseudohomophony I Test akt is a Polish word meaning a document. ZS read this word correctly. In the Structured Nonwords Test 5 items form Polish words (ish - that; keem , the instrumental case of "who"; kreme, Crimea; drap a nautical word for "flag" and bram, the genitive plural of "gate"). ZS read ish correctly on one occasion and not on another. He read keem and kreme correctly but misread the remaining items. The differences in scores which result from discounting the items which form Polish words and which are read correctly do not affect the significance of the effects of different variables.

The second problem posed by bilingualism is in the classification of error responses to nonwords as Incorrect Nonwords. These responses may form Polish words and hence be more appropriately classified as lexicalisations. The same caveat applies to the classification of nonword error responses to words. All such responses were therefore checked by a Polish speaker to see whether or not they were Polish words. Responses which do form Polish words are marked with a 1 in the error corpus. There are very few such responses and , since reclassifying them makes no significant difference to the proportions of errors in different categories the original classification is retained. Conversely, only 1 error response to a Polish word and 2 error responses to a Polish nonword form English words. The error responses to Polish nonwords include 3 Polish words. These items are marked 1 in Table 4.8.13.

4.8.9 Summary

ZS presents with a phonological dyslexia.in which nonword reading is severely impaired but not totally abolished. Impaired processing of nonwords is evident both in English and in ZS's native language, Polish. Evidence from nonword reading tests indicates that the major impairment within the phonological route is in the Phoneme Allocation System and that there is some impairment of the Blender. ZS relies on the lexical-semantic route for reading words aloud, there is no evidence that the direct route is functional.

4.9 Case Report VII: PG

4.9.1 Neurological Background

PG sustained a CVA in June, 1982 at the age of 34. She was admitted to Good Hope Hospital with severe aphasia and a right hemiplegia. No information regarding site of lesion is recorded in the medical notes; conduction aphasia is sometimes associated with a lesion in the arcuate gyrus. When first tested in October, 1983, the hemiplegia had resolved into a mild right hemiparesis and PG was able to write with her preferred right hand. PG had suffered from kidney trouble since childhood, had had one kidney removed and required frequent hospitalisation. She died in March, 1985.

4.9.2 Educational and Occupational Background

PG left school at the age of 15 and worked in an office while attending college on a day release basis for secretarial training. At the time of her CVA she was working as personal secretary to the managing director of a large midlands-based company. She reported reading numerous novels and newspapers and magazines prior to her CVA.

4.9.3 Aphasia and dysgraphia

PG presented with a conduction aphasia, initially severe, which by October 1985 was comparatively mild. She had no difficulty communicating in everyday and social situations although her speech, which was fluent, was interrupted by frequent word-finding pauses and literal and occasional verbal paraphasias were evident. The following example of spontaneous speech was elicited by the request "Tell me a bit about what you've being doing this week".

"Well, I've been, the first time I've had my car, for a long time and, been over to a disco and er, been over to stay with my friend and er, got to go to the hospital. Watching television."

PG was then asked "Have you decided where you're going on holiday this year?". "/s/ Spain, or somewhere like that. Been to /sp/, um, Africa, been there. (Examiner: How long ago was that?) 'bout two years ago I went to there. (Examiner: Where did you stay in Africa?) Um.... West Africa. (Examiner: Tell me a bit about it. Who did you go with, and ..?) Um, went on a plane and er, had to go twice because, um, the aeroplane had to come down first and then we had to have some more .... petrol, and that, and then went away from /sp/ .... um then from Africa and then we stayed there. It was ever so hot and it was just before Christmas so it was really hot there and it was .... freezing here.

Auditory comprehension was impaired especially in the Complex Material subtest of the BDAE in which PG obtained a zero score. Repetition was above average when items were single words (8/10) but poor when short phrases were presented (High Probability: 2/8; Low Probability: 0/8). Scores on all naming subtests were above average. Scores on tests of reading comprehension were high on symbol discrimination and word matching subtests (10/10 on each) but low on the comprehension of oral spelling subtest (0/10) and average or below average on word recognition (5/8) and sentences and paragraphs (5/10). A copy of the BDAE Z-score profile is provided in Appendix I.

There was an accompanying dysgraphia in which nonwords (2/10) were written less well than short, high-frequency words (9/10) although individual letters were written efficiently in response to dictated phonemes (9/10). PG wrote correctly 65% of words dictated to her.

4.9.4 Neuropsychological Baseline Tests

PG obtained a Memory Quotient of 61 on the Wechsler Memory Scale. Her digit span was 2 digits forward and 2 backward. A score of 15/36 on the Token Test indicates a severe impairment of auditory comprehension. She obtained an I.Q, equivalent of 81 on the spoken and 91 on the written version of the PPVT and a score of 35/60 on the extended Boston Naming Test.

4.9.5 Reading and repetition tests

The results of reading and repetition tests are shown in Tables 4.9.1 to 4.9.9. A transcription of PG's reading of the passage of text is provided in Appendix II. Error types are shown in Tables 4.9.10 to 4.9.12. Figure 4.9.1 shows the effect of word length on reading speed. Proportions of errors falling into the main error categories and proportions of different types of response are shown graphically in Figures 4.9.2 to 4.9.5.

Table 4.9.1 READING AT THE SINGLE LETTER LEVEL

Number Test		Number Correct	Percentage Correct
Single letter naming	n = 26	25	96
Single letter sounding	n = 24	22	92
Single letters from a string	n = 20	18	90
Cross-case letter matching	n = 58	52	90

Table 4.9.2 READING AT THE SINGLE WORD LEVEL

Test	Number Correct	Percentage Correct	Significant effect of Variable
Easy lexical decision n = 50	48	96	
Difficult lexical decision n = 40	29	73	
Imageability (standard)			
High Imageable n = 28	23	82	+
Low Imageable n = 28	14	50	
Imageability (difficult)			
High Imageable n = 20	13	65	+
Low Imageable n = 20	4	20	
Part of speech (easy)			
Noun n = 20	20	100	-
Verb n = 20	19	95	
Adjective n = 20	18	90	
Function word n = 20	20	100	
Part of speech (difficult)			
Noun n = 20	11	55	-
Verb n = 20	11	55	
Adjective n = 20	16	80	
Function word n = 20	13	65	
Part of speech (revised)			
Noun n = 25	23	92	-
Verb n = 23	21	91	
Adjective n = 25	23	92	
Function word n = 37	36	97	
Regularity of spelling (standard)			
Regular n = 39	32	82	-
Irregular n = 39	31	79	
Frequency			
High Frequency n = 23	23	100	-
Low Frequency n = 23	22	96	
Word length			
3-letter n = 10	8	80	-
4-letter n = 10	10	100	
5-letter n = 10	9	90	
6-letter n = 10	7	70	
7-letter n = 10	7	70	
8-letter n = 10	5	50	
Presence of Suffix I			
Suffixed n = 30	26	87	-
Unsuffixed n = 30	28	93	

Table 4.9.3 COMPREHENSION TESTS

Test	Number correct	Percentage correct
Synonym matching		
High Imageable n = 38	37	97
Low Imageable n = 38	32	84
Semantic Probe n = 16	15	94
Comprehension of functors n = 18	18	100

Table 4.9.4 TESTS OF MORPHOLOGICAL KNOWLEDGE

Test	Number correct	Percentage correct
Single word test n = 32	26	81

Table 4.9.5 TESTS OF NONWORD PROCESSING

Test	Number correct	Percentage correct	Significant effect of Variable
Reading aloud			
Easy Lexical Decision			
Words n = 25	24	96	+
Nonwords n = 25	8	32	
Nonwords with inconsistent letters			
With inconsistent letter n = 36	14	39	-
Without inconsistent letter n= 36	15	42	
Nonwords synthesised from words			
with colour cue n = 10	7	70	-
without colour cue n = 10	6	60	
Segmentable words			
Visual mode n = 30	30	100	+
Auditory mode n = 30	14	47	
Hidden words n = 20	15	75	
Sound Blending I			
Words n = 24	14	58	-
Nonwords n = 8	0	0	
Sound Blending II n = 35	4	11	
Consistent and Inconsistent nonwords			
With consistent segment n = 15	7	47	-
With inconsistent segment n = 15	8	53	
Pseudohomophony I			
Pseudohomophones n = 15	7	47	-
Non-pseudohomophones n = 15	7	47	
Pseudohomophony II			
Pseudohomophones n = 10	6	60	-
Non-pseudohomophones n = 10	2	20	
Inappropriately suffixed nonwords n = 25	21	84	
Affixes in isolation n = 10	9	90	

Table 4.9.6 READING ALOUD NONWORDS OF DIFFERENT STRUCTURE

Type	Example	Number of correct	Percentage correct
A	tad	9	45
B	ank	15	75
C	ead	10	50
D	eth	16	80
E	tood	13	65
F	dack	9	45
G	dunt	8	40
H	afe	10	50

n = 20 in each list

Table 4.9.7 READING ALOUD WORDS AND NONWORDS OF DIFFERENT STRUCTURE

Type	Percentage of words correct	Percentage of nonwords correct
A	90	30
E	100	60
F	100	50
G	100	20

n = 10 in each list

Table 4.9.8 SILENT TESTS OF PHONOLOGY

Test	Number correct	Percentage correct
Silent test of phonology I		
Nonword n = 50	27	54
Regular word n = 50	37	74
Irregular word n = 50	41	82
Silent test of phonology II n = 40	24	60

Table 4.9.9 TESTS OF REPETITION ABILITY

Test	Number correct	Percentage correct
Pseudohomophony I		
Words n = 15	13	87
Nonwords n = 15	12	80
Easy lexical decision		
Words n = 25	23	92
Nonwords n = 25	18	72
Nonwords of different structure		
Type A n = 10	8	80
Type B n = 10	8	80
Type C n = 10	8	80
Type D n = 10	8	80
Type E n = 10	9	90
Type F n = 10	8	80
Type G n = 10	5	50

Table 4.9.10 READING ERRORS: WORDS

		Number of errors	Percentage of errors
Visual		42	25
Sharing initial letter(s) with stimulus	22		
Sharing init. & fin. letter(s) with stimulus	12		
Sharing final letter(s) with stimulus	3		
Sharing medial letter(s) with stimulus	2		
Sharing letter(s) not in corresponding psns.	3		
Visual or Semantic		2	1
Visual or phonemic paraphasia		14	8
Derivational		6	4
Derivational or Inflectional (ing)		1	1
Inflectional		6	4
Verbs	5		
Adjectives	1		
Function Word Substitutions		3	2
Visually similar	1		
Visually dissimilar	2		
Semantic		4	2
Phonemic paraphasias		37	22
Addition, omission, substitution or reordering of word segments		42	25
Other		14	8
Complex Function Word Substitions criteria	7		
Possibly visual, not satisfying criteria phonemic paraphasis plus visual	2		
Regularisation/alternative realisation	2		
Unclassified	3		
TOTAL ERRORS		171	
Words misread		127	16
Omissions		11	1
Words read correctly		673	83
TOTAL PRESENTED		811	
Error responses corrected		32	
Additional errors due to multiple attempts		12	

Table 4.9.11 <u>READING ERRORS NONWORDS</u>

		Number of errors	Percentage of errors
Lexicalisations			
Visually similar to stimulus 94		107	44
sharing initial letter(s) with stimulus	35		
sharing init. & fin.letter(s) with stimulus	30		
sharing final letter(s) with stimulus	24		
sharing medial letter(s) with stimulus	3		
sharing letters not in corresponding posns.	2		
Visually distinct from stimulus 13			
sharing initial letter(s) with stimulus	5		
sharing final letter(s) with stimulus	4		
sharing letter(s) not in corresponding posns	3		
sharing phoneme(s) but not letters with stimulus	1		
Incorrect nonwords		128	53
gross errors of grapheme-phoneme conversion	60		
Substitution of single grapheme/phoneme	41		
Addition of single grapheme/phoneme	16		
Omission of single grapheme/phoneme	8		
phonemic realisation of silent <u>e</u>	1		
failure of marking function of silent <u>e</u>	2		
Other		6	2
Blending 4			
Segmentation/Blending 1			
Segmentation/Visual 1			
TOTAL ERRORS		241	
Nonwords misread		172	51
Omissions		1	0
Nonwords read correctly		164	49
TOTAL PRESENTED		337	

Corrections	29
Additional errors due to multiple responses	40

Table 4.9.12 TEXT READING ERRORS

	Number of errors	Percentage of errors
Errors on stem of content words (n = 56)	3	5
Derivational/inflectional errors on content words	2	
Errors on function words (n = 69)	5	9
TOTAL WORDS IN PASSAGE	125	

Fig. 4.9.1 Word length and reading speed : PG

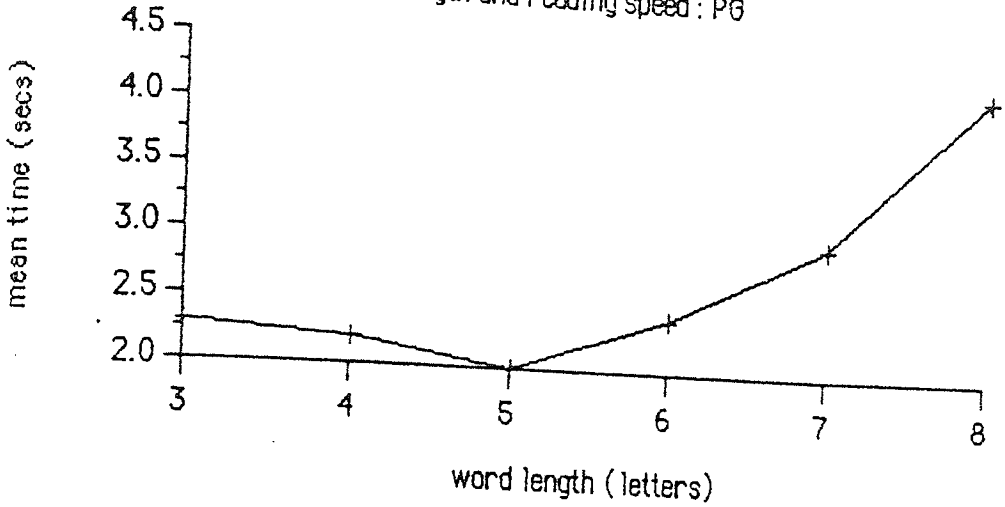


Fig. 4.9.2 Reading responses to words : PG

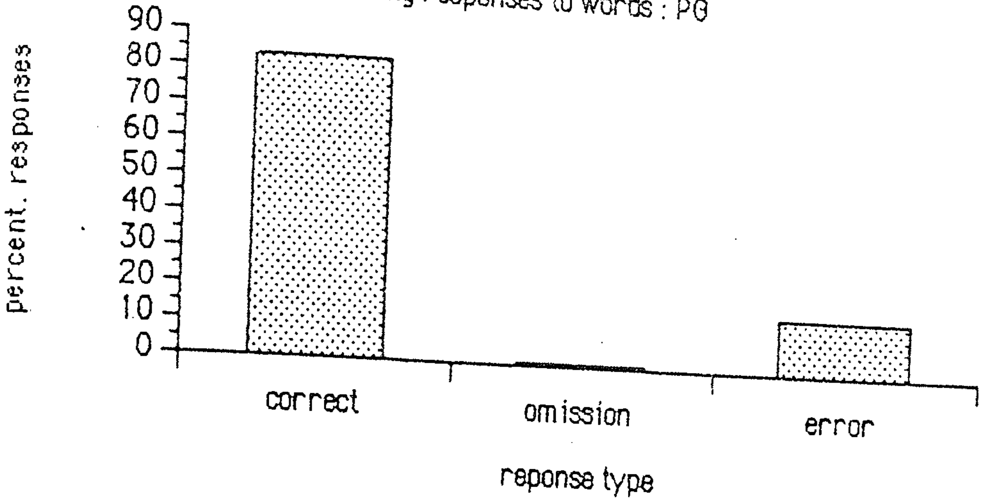


Fig. 4.9.3 Reading responses to nonwords : PG

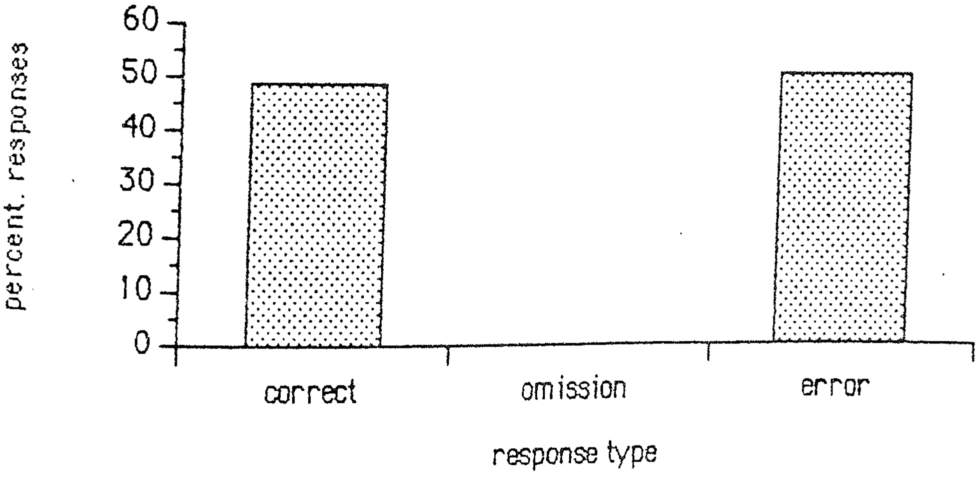


Fig. 4.9.4 Types of error response to words : PG

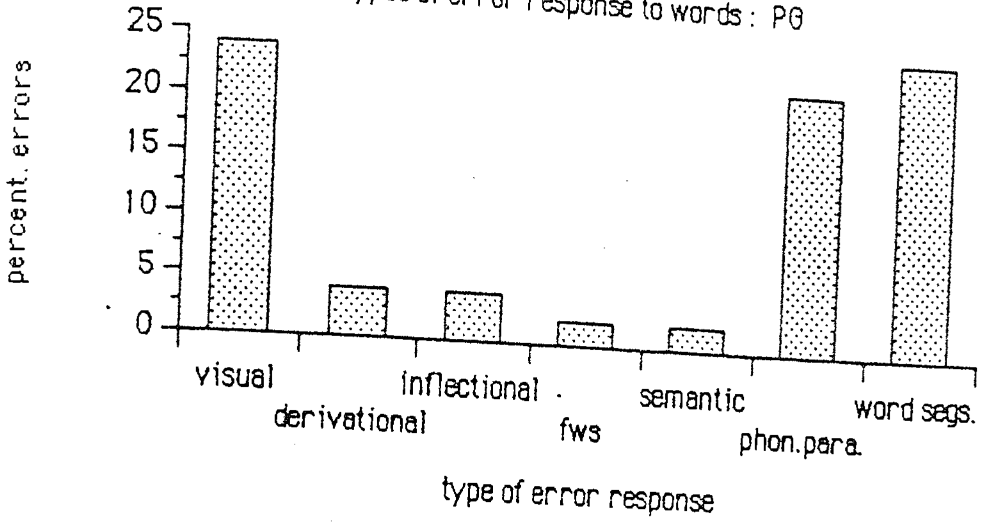
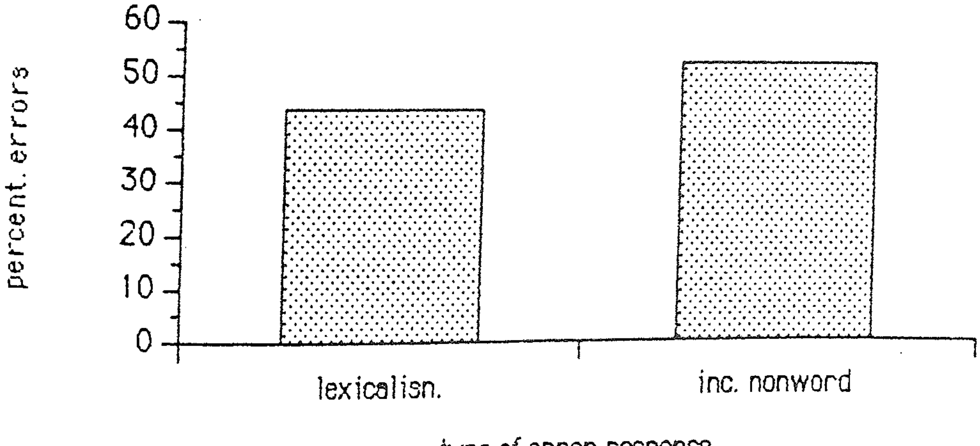


Fig. 4.9.5 Types of error response to nonwords : PG



4.9.6 Analysis of Test Results

4.9.6.1 Reading at the single word level

There is no significant effect on performance of varying Part of Speech (Easy: scores too high to allow accurate statistical analysis; Difficult X^2 (3df) = 3.6, $P>.05$; Revised: X^2 (3df) = 1.4*, $P>.05$), Regularity of Spelling (X^2 (1df) = .078, $P>.05$), Frequency ($Z = 0$. $P>.05$) or Word Length (Accuracy: Kendall's $S = -10$, $P>.05$; Speed: Kendall's $S = 9$, $P>.05$). There is no effect of the Presence of a Suffix ($Z = .43$, $P>,05$). There is an effect of Imageability on Performance (Easy: X^2 (1df) = 6.5, $P<.05$, Difficult: X^2 (1df) = 8.3, $P<.01$). Performance is better on the easy than on the difficult lexical decision test (Easy: Hit Rate = .99, False Alarm Rate = .04, d' = 4.07; Difficult: Hit Rate = 1, False Alarm Rate = .6, d' = 2.06).

4.9.6.2 Tests of comprehension and morphological knowledge

There is an effect of imageability in the test of reading aloud items in the synonym matching task (X^2 (1df) = 6.3, $P<.05$). The effect of imageability does not quite reach significance in the synonym matching task ($Z = 1.6$, critical of value of Z for significance at the 5% level = 1.64). There is no significant difference between scores on the reading and the matching tasks (X^2 (1df) = .3, $P>.05$). PG's score of 15/16 on the Semantic Probe Test is significantly above chance (Chance = 8($\pm$4) and her score on the Comprehension of Functors Test is 100%. Performance on the single word test of morphological knowledge is somewhat impaired (Hit Rate = .8, False Alarm Rate = .1, d' = 2.12).

4.9.6.3 Tests of nonword processing

Words are read better than nonwords in both tests (Easy Lexical Decision: X^2 (1df) = 22.2, $P<.001$; Words and Nonwords of Different Structure: X^2 (1df) = 30.8, $P<.001$). There is no effect of the presence of an inconsistent letter (X^2 (1df) = .06, $P>.05$) or an inconsistent segment (X^2 (1df) = .13, $P>.05$). There is no significant effect of pseudohomophony (I: scores identical on the two types of item; II: X^2 (1df) = 3.3, $P>.05$). There is no significant effect of the presence of a colour cue in the Nonwords Synthesised from Words Test ($Z = 0$, $P>.05$). There is a significant difference between scores on the Segmentable Words Test in the two modalities (X^2 (1df) = 21.8, $P<.001$). There is a significant difference between performance on words and performance on nonwords in the Sound Blending I Test ($Z = 2.4$, $P<.01$). There is no overall effect of type of nonword in the Structured Nonwords Test (X^2 (1df) = 12.9, $P>.05$). Type D nonwords are read significantly better than Type A nonwords (X^2 (1df) = 4.9, $P<.05$) and than Type C nonwords (X^2 (1df) = 3.9, $P<.05$) and Type B nonwords are read significantly better than Type G nonwords (X^2 (1df) = 5, $P<.05$). There is no significant difference between scores on Types C and E and Types D and F nonwords (X^2 (1df) = .2 $P>.05$) or between scores on Types B and G and Type A nonwords (X^2 (1df) = .86, $P>.05$). Scores on Types C and E and Types B and G nonwords are identical. Performance is poor on all Silent Test of Phonology, the lowest value for d' being obtained on the nonword version of the first test (I: Nonword: Hit Rate = .5, False Alarm Rate = .4, d' = .26; Irregular Word: Hit Rate = .8, False Alarm Rate = .1, d' = 2.12; II:

Hit Rate = .7, False Alarm Rate = .5, d' = .52).

4.9.6.4 Tests of repetition ability

There is no significant difference between repetition of words and nonwords (Pseudohomophony I: $Z = 0$, $P > .05$; Easy Lexical Decision: $Z = 1.5$, $P > .05$). There is no significant effect of type of nonword on the repetition of Structured Nonwords (X^2 (1df) = 5.3*, $P > .05$).

4.9.6.5 Reading Errors: Words

The same proportion of errors (25%) fall into the visual and the substitution of word segments categories. Phonemic paraphasias account for 22% of errors. There is no significant difference between the number of items in the latter and the number in either of the former categories (X^2 (1df) = 3.2, $P > .05$). The derivational and inflectional error categories contain the same number of items.

4.9.6.6 Reading Errors: Nonwords

There is no significant difference between the number of lexicalisation errors and the number of errors which are incorrect nonwords (X^2 (1df) = 1.9, $P > .05$). The latter category accounts for the highest proportion of errors (53%). Significantly more lexicalisation errors are visually similar to the stimulus than are visually distinct (X^2 (1df) = 61.3, $P < .001$).

4.9.6.7 Reading Errors: Text

There is no significant difference between the number of errors made on the stems of content words and the number of errors made in response to function words in reading the passage of text ($Z = .06$, $P > .05$).

4.9.7 Discussion of Reading Impairment

4.9.7.1 Reliance on the lexical-semantic route for reading aloud

There is no evidence to suggest that PG is able to use the direct route when reading words aloud. Performance in the comprehension task in the Synonym Matching Test is at the same level as performance in the reading task. This, of course, is compatible with both direct and lexical semantic routes being operational. Furthermore, there is an effect of imageability (performance on high-imageable being better than performance on low-imageable items) in all reading tests. More high-imageable than low-imageable items are judged correctly in the synonym matching task; the difference in scores does not quite reach the 5% significance level but is so close to it that there is no reason to suspect a dissociation between reading and matching performance. Such a dissociation in which there is an effect of imageability in reading aloud but not in comprehension is not predicted by the standard model and would be extremely difficult to explain. The presence of an imageability effect in reading aloud suggests reliance on the lexical-semantic route, since there is no reason why a semantic variable should affect reading performance when the direct route is in use.

4.9.7.2 The absence of a part of speech effect

Since PG appears to rely on the lexical-semantic route for reading aloud the absence of a part of speech effect and, in particular the absence of a function word deficit is of interest. There are very few function word substitutions in PG's error corpus (these account for only 2% of total errors) and only 1 of these errors is visually distinct from the stimulus. Thus it is likely that the remaining function word susbtitutions are in fact visual errors. There is no evidence of any impairment in the comprehension of functors (PG scored 100% in this test). Nor is there evidence of a function word deficit in reading text. This case, like those of CB (Case Report IV) and ZS (Case Report VI) appears to demonstrate that reliance on the lexical-semantic route does not necessarily predict poor performance on function words. However, as noted in Case Report IV (Section 4.6.7.1.3) the ability to make some minimal use of the phonological route may compensate for the inefficiency of the lexical-semantic route in dealing with grammatical morphemes.

4.9.7.3 Derivational and Inflectional Errors

PG makes very few errors which fall into these categories which account for only 8% of total errors. Since there is no effect of the presence of a suffix on reading performance, there is reason to doubt whether this is a genuine category of error. There is no significant difference between the number of inflectional and the number of derivational errors recorded. This is compatible with these errors resulting from visual confusion. PG is able to process affixes fairly efficiently. She read aloud 9/10 affixes in isolation and nonword reading performance increases from an overall performance of 49% correct to 84% correct when stimuli are inappropriately suffixed nonwords. This level of attainment is comparable to that recorded for word reading in which the overall success rate is 83%. Only 1/4 errors in the Inappropriately Suffixed Test involves substitution of the affix. The remaining errors result from substitution of the stem such that, in 2/3 cases, the response is an appropriately suffixed word. The high success rate on this test indicates that the Morphological Decomposition System functions efficiently. The high score on the test of affix reading in isolation provides some support for Job and Sartori's (1984) proposal that there are separate visual rcognition devices for affixes. It is not compatible with the suggestion that affixes are read via the phonological route (see Chapter 2, Section (2.1.5) since affixes in isolation are read so much better than nonwords. There is some impairment in the comprehension of inflected ending as tense indicators although this is not severe. The success rate on the test of morphological knowledge at the single word level (81% correct) is comparable with PG's score on reading affixed words (87% correct on suffixed words in the Presence of Suffix I Test). These scores do not differ significantly (X^2 (1df) = .3, $P >$ .05). Thus the pattern of results does not suggest that affixes are read aloud in the absence of comprehension of their morphological significance.

4.9.7.4 Phonemic paraphasias

This error category accounts for a high proportion of PG's errors (22%). A further 8% of errors may fall into this category or may be visual errors. This error category is discussed in Chapter 3. The account of these errors as articulatory in origin is supported in this case by the occurrence of similar errors in spontaneous speech. Six errors in the "literal paraphasia" category are recorded in the BDAE profile.

4.9.7.5 Substitution, addition or omission of word segments

The majority of patients reported in this work have made a few errors which have been assigned to this category (see Table 4.8.13). The category is discussed within this Case Report because PG made a large number of errors of this type. (Errors in this category account for 25% of total errors). Errors of this type tend to occur on longer words and in most cases occur when reading of the lexical items in the Difficult Lexical Decision Test is required. "Word segments" usually correspond to syllables; the alternative term is used because units larger than the syllable are sometimes involved (e.g. PG: lubricant -> /ˌlʌbrɪkænˈeɪʃn/ in which the frequently-occurring word final segment #ation is substituted for the letter t).

Although errors involving the substitution, addition and omission of word segments are grouped together, the majority of errors involve substitution of segments. The omission of part of a word (e.g. PG: standardisation -> / ˈstændəˌdeɪʃn /) may be due to rapid

Table 4.9.12 Examples of errors in the substitution, omission or deletion of word segments category

Case Report	Stimulus	Response
II: DP	vestibule impropriety	/'vɛstɩtʃut/ /ɩm'pɜsɩkjut/
III: TW	procastination metropolis	/pænɩ'neɩʃn/ /'mɛtroʊ'skoʊp/
IV: CB	inappropriateness dissatisfaction	/ɩn'æproʊeɩt - ɩvi/ /dɩsɩn'fæktəri/
V: JS	inappropriateness accordian	/ɩnə proʊpri'eɩʃn/ /ə kɔdɩ'eɩʃʊn/
VI: ZS	increment unreality	/ɩnkrə'meɩtɩd/ /ʊnriæ'bɩlɩti/
VII: PG	unreality lubricant	/ri'lɩvəti/ /lubrɩkæn'eɩʃn/
VIII: FW	ingratitude vaccination	/ɩŋgræ'tʃuɩti/ /i'vækju'leɩʃn/
IX:	linguistically recapitulate	/ɩn'kwɛstɩgəl/ /rikeɩpə'bɩlɩtɩz/

deterioration within the response buffer. The "substitution" and "addition" errors are less satisfactorily explained in this way. It is also relevant to note that errors of this type sometimes occur in the nonword error corpora of these patients. Such errors tend to occur when long nonwords (e.g. from the Difficult Lexical Decision Test) are presented for reading aloud (e.g. CB: <u>imparsonious</u> → /ˈɩmprɒˌpɔʃənɩt/ WPB: <u>laborcolator</u> → /leɩbəˌkʌləreɩtə/.)

Examination of errors of this type made in response to words and nonwords suggests the following account of this error type. Multisyllabic items (like monosyllabic items) activate orthographic neighbours in the word recognition system. Because of the length of the item, there is a delay in selecting the correct match and in certain cases, 2 (or more) visual neighbours are processed as far as the response buffer either via the direct route or via the lexical-semantic route. The two phonological representations become confused in the response buffer or in the process of articulation, possibly in the same way that confusions of more than one word occur in the spontaneous speech (Fromkin, 1983) and the spontaneous writing (Hotopf, 1980) of normal readers. Neither Fromkin nor Hotopf specify in great detail how these "Blend" errors occur, but brief accounts of the process are given. In normal speech it is usually 2 semantically related words which are confused (e.g. Fromkin cites <u>clarinola</u>, a blend of <u>clarinet</u> and <u>viola</u>). Fromkin states that "where there are .... alternative possibilities, rather than making an immediate selection (the speaker) brings them both into a buffer storage compartment, with their phonological specifications. Either a selection occurs at this point, or the words are blended, resulting in the above kind of errors." Thus PG's error lubricant -> / ˌlʊbrɪkæn'eɪʃn / could the result from confusion of lubricant and lubrication; WB's recapitulate -> / 'rikeɪpəˌbɪlɪtɪz / from confusion of recapitulate, recapture or recap with capabilities and TW's metropolis -> / 'mɛtrooˌskoop / from confusion of metropolis or metric with microscope. In the case of nonwords, the errors result from the confusion of 2 or more visually similar real words, so that, to use the examples given, CB's imparsonious -> / 'ɪmprɒˌpɔʃənɪt / could result from confusion of improper and proportionate and WB's laborcolator -> /'leɪbəˌkʌləreɪtə/ from confusion of labour, colour and curator. When the direct route is intact, little can be done to investigate this hypothesis. When the patient is relying on the lexical-semantic route, however, confirmation should be available by asking for definitions (a more sensible request when items are words). If the account is correct an either/or definition should be given when the 2 words confused are not semantically or derivationally related. Such a test was to have been administered to PG who a) makes a substantial proportion of the type of error under discussion and b) reads via the lexical-semantic route. PG died before testing was completed. No other patient who had been shown to be relying on the lexical-semantic route was available for further testing. Therefore no evidence can be offered to support or refute the account.

4.9.7.6 The nonword reading impairment

4.9.7.6.1 General comments

PG read 164/337 (49%) nonwords presented. A high proportion of her errors (53%) are incorrect nonwords. The size of this error category in conjunction with the proportion of nonwords that are read correctly indicates that the phonological route is operative though impaired. A high proportion (47%) of these errors are classified as gross or multiple errors of grapheme-phoneme conversion. The remaining 53% of errors involve the substitution, omission or addition of a single phoneme. It is possible that the latter errors and a number of lexicalisation errors (marked with an asterisk in the error corpus) could result from an output difficulty of the type which produces phonemic paraphasias in word reading and spontaneous speech. Since phonemic paraphasias are counted as errors in word reading, similar errors in nonword reading would not reduce the extent to which reading and nonword reading abilities are dissociated. Performance on other tests indicates that the nonword reading impairment is not simply the result of difficulty in outputting a phonological representation. Performance on the Nonword Silent Tests of Phonology is very poor. Repetition of nonwords is only mildly impaired (a total of 84% of nonwords were repeated correctly)and there is no significant difference between the repetition of words and nonwords. An output difficulty should be apparent in repetition as well as reading tasks. Finally, if there is difficulty in articulating unfamiliar segments, pseudohomophones should be read better than nonwords which are not pseudohomophones. There is no effect of pseudohomophony on

PG's reading of nonwords.

4.9.7.6.2 The locus of impairment within the phonological route: nonwords of different structure test

PG read correctly 56% of items in this test. There is no overall effect of type of nonword. Significant differences are found between 3-letter stimuli containing a consonant cluster (Type D items) and 3-letter, 3-phoneme stimuli (Type A items) and between Type D items and 3-letter stimuli containing a vowel digraph (Type C items). There is also a significant different between 3-letter, 3-phoneme stimuli containing a consonant cluster (Type B items) and 4-letter, 4-phoneme stimuli containing a consonant cluster (Type G items). However, there is no overall effect of number of phonemes in the stimulus. PG read correctly 36/60 2-phoneme, 46/80 3-phoneme, and 8/20 4-phoneme items. There is no significant difference between these scores (X^2 (2df) = 2.3, $P > .05$). This pattern of scores does not allow conclusions to be drawn regarding the locus of impairment. It is probable that all subsystems are to some extent impaired. When items contain a consonant unit or a consonant cluster, length appears to be an important factor. Type D items are read better than Type F items and Type B items than Type G items. However, when items contain a vowel digraph this pattern is not maintained (Type E items are read better than Type C items).

4.9.7.6.3 The locus of impairment within the phonological route: additional evidence

4.9.7.6.3.1 Single letter processing

PG was able to match cross-case letters, to name and to sound letters fairly efficiently. Her score was 90% or above in all tests. However both PG and her speech therapist report that she had been retaught the grapheme-phoneme correspondences. These results indicate that the abstract letter recognition system is only minimally impaired.

4.9.7.6.3.2 The resegmentation system

PG's performance on segmentation tests which do not involve the reading aloud of nonwords is good. She was 100% correct in the Visual Segmentable Words Test. Performance on this test in the auditory mode was significantly poorer (47% correct). She was able to find a word hidden in a nonword letter string on 15/20 (75%) occasions.

4.9.7.6.3.3 The Phoneme Allocation System

As mentioned earlier PG is able to give the sounds of letters reasonably efficiently. However, this ability does not necessarily indicate an unimpaired phoneme allocation system since it can dissociate from nonword reading ability. There is no effect of the presence of an inconsistent grapheme on reading performance either in the Inconsistent Letters Test or the Structured Nonwords Test. The proportion of errors (28%) which are incorrect nonwords and which result from misconversion of a single grapheme does suggest some impairment of the phoneme allocation system. However, this error category is difficult to interpret in this case since errors could be phonemic paraphasias (see Section 4.9.7.3).

4.9.7.6.3.4 The Blender

Performance on auditory sound blending tests provides evidence of impairment especially when items to be blended are nonwords. Performance on nonwords (zero score) is significantly poorer than performance on words (58% correct) in the Sound Blending I Test and is poor on the Sound Blending II Test (11% correct). Scores on the Nonwords Synthesised from Words Test are fairly high in comparison with scores on other nonword reading tests however. This suggests that PG retains the ability to blend word-sized units when they are presented visually. The presence of a colour cue does not facilitate performance in this test (with colour cue: 70% correct, without colour cue: 60% correct). PG appeared to recognise the stimuli as being formed from 2 words even when no colour cue was provided. This is to be expected in view of her excellent score on the Visual Segmentable Words Test.

4.9.7.6.3.5 Reading by analogy

There is no effect of the presence of an inconsistent segment on PG's reading aloud of nonwords. This lack of effect provides evidence that PG does not read nonwords by a process of lexical analogy. As mentioned earlier, testing was not completed in this case and the

Reading by Analogy Tests were not administered.

4.9.8 Summary

PG presents with a phonological dyslexia in which nonword reading is severely impaired but not totally abolished. The results of nonword reading tests do not give a clear indication of the locus of impairment within the phonological route. It is concluded that all subsystems are to some extent impaired. There is evidence to suggest that PG relies on the lexical-semantic route for reading words aloud.

4.10 Case Report VIII: FW

4.10.1 Neurological Background

FW, a right-handed women, born in 1912, had a history of heart trouble and thyroid and liver problems. In 1976 she sustained a CVA following which a right hemiplegia and aphasia were evident. She made a good recovery after this incident but in August 1983, at the age of 71, suffered a heart attack followed by another, less severe CVA. After this incident she again presented with a right hemiplegia which necessitated writing with the non-preferred hand, and aphasia. No precise localization data is available although the clinical picture suggests a left hemisphere lesion. In June, 1984, FW sustained a third CVA. She was admitted to Queen Elizabeth Hospital but did not regain consciousness and died a few days after this incident.

4.10.2 Educational and occupational background

FW had trained in secretarial work after leaving school and at the time of her retirement she was employed as personal secretary to the principal of a local College of Education. She was well-spoken and knowledgeable and reported having read and written a great deal prior to her CVA. She found her writing difficulties particularly frustrating as she had been in the habit of corresponding at length with friends and relations as her health did not permit much travelling.

4.10.3 Aphasia and Dysgraphia

FW's sponaneous speech was fluent but frequently interrupted by word-finding pauses. Word-finding difficulty was sometimes revealed by circumlocution rather than pauses. Her spontaneous speech and test results on the BDAE was suggestive of anomic aphasia although deficits in auditory comprehension and retention are evident and the profile deviates from that of the classic anomic. The following example of spontaneous speech was elicited by the request to describe the "Cookie Theft" picture in the BDAE.

"Oh, dear now ..... well .... the lady's she's, the lady is ..... she is wiping a dish or a day and she's .... now, wait a minute, what has she done, well she hasn't done it ... what has she done with the water, what do you do, she's, she's .... the water, that's it .... it might be wrong, what did she do ... he water from the sink ... where did it go? .... what did I say? (Examiner: You said "the water from the sink") ... overflowed. (Examiner: And what about this side of the picture. What's happening over here?) "Well the boy and the girl .... what they were doing ... well the boy, no, the boy was ... what's he doing ... he was opening, he was opening, was he opening? .... a jar from the top shelf of the cupboard. He took, he was, what was he doing, what's he doing, what he do then ... he was taking ... taking out whatever the tablets ... not tablets ... oh cookies (having read jar) cookies then ... he was taking out the cookies out of the tin and he was giving the boy, no, what was he doing, he'd got them there (pointing) and he was going to do there (pointing to girl's outstretched hand) .... oh ... I've just realised ... he'd done something wrong with the stool, he was, what was he doing ... what do you do when you upset it ... he was upsetting it, not upsetting it ... he was slipping. Well I haven't got yet to what he was doing to ... the girl, was, well the little girl ... she was asking, no she wasn't ... what was she doing .... I can't ... I know what I want to say ... the girl was .... I shall have to leave that for a minute."

Auditory comprehension is somewhat impaired. Scores on auditory comprehension subtests are at or above the 60th percentile except for the score on the Commands Subtest (8/15). Naming scores are between the 50th and 80th percentiles (Responsive naming: 12/30; Confrontation naming: 93/114; Animal naming: 4/23). Repetition scores are on the 60th or 70th percentiles. A few literal and one verbal paraphasia were recorded during the administration of the BDAE. Verbal paraphasias were more common in spontaneous speech than this figure suggests. These paraphasias were frequently of a semantic nature; that the word was inappropriate was clear from the context (e.g. girl → "boy"; optician → "dentist"; see → "hear"). Reading comprehension scores were higher than auditory comprehension being at the 80th or 90th percentile on Word Recognition, Word-Picture Matching and Reading Sentences and Paragraphs subtests. Comprehension of oral spelling was at zero. Oral reading scores were at or just below the 80th percentile. A copy of the BDAE subtest summary profile is provided in Appendix I.

There was a severe dysgraphia in this case. Performance on written spelling tasks was effortful and very slow. FW was able to write correctly only 5/30 dictated words. The 30-word test took almost an hour to complete. Performance was significantly improved by the use of a cuing technique in which FW was presented with the initial letter and appropriate number of dashes representing letters in the dictated word written on a sheet of paper. She scored 18/30 on a test containing items matched with items in the first test for frequency, length and part of speech. This version of the test was completed in 15 minutes.

4.10.4 Neuropsychological Baseline Tests

FW obtained a Memory Quotient of 77 on the Wechsler Memory Scale. Her digit span was 3 digits forward and 2 backward. A score of 12/36 on the Token Test indicates a severe impairment of auditory comprehension. She obtained an I.Q. equivalent of 93 on the spoken version of the PPVT (the written version was not administered) and a score of 34/60 on the extended Boston Naming Test.

4.10.5 Reading and repetition tests

The results of reading and repetition tests are shown in Tables 4.10.1 to 4.10.8. A transcription of FW's reading of the passage of text is provided in Appendix II. Error types are shown in Tables 4.10.9 to 4.10.11. Proportions of errors falling into the main error categories and proportions of different types of response are shown graphically in Figures 4.10.1 to 4.10.4.

Table 4.10.1 READING AT THE SINGLE LETTER LEVEL

Test	Number	Correct	Percentage Correct
Single letter naming	n = 26	25	96
Single letter sounding	n = 24	4	17
Single letters from a string	n = 20	18	90
Cross-case letter matching	n = 58	54	93

Table 4.10.2 READING AT THE SINGLE WORD LEVEL

Test	Number Correct	Percentage Correct	Significant effect of Variable
Easy lexical decision n = 50	50	100	
Difficult lexical decision n = 40	21	53	
Imageability (standard)			
High Imageable n = 20	17	85	-
Low Imageable n = 20	18	90	
Imageability (difficult)			
High Imageable n = 20	15	75	
Low Imageable n = 20	7	35	
Part of speech (easy)			
Noun n = 20	20	100	-
Verb n = 20	19	95	
Adjective n = 20	19	95	
Function word n = 20	14	70	
Part of speech (revised)			
Noun n = 25	23	92	-
Verb n = 23	21	91	
Adjective n = 25	24	96	
Function word n = 37	35	95	
Regularity of spelling (standard)			
Regular n = 39	37	95	-
Irregular n = 39	35	90	
Frequency			
High Frequency n = 23	23	100	-
Low Frequency n = 23	23	100	
Presence of Suffix I			
Suffixed n = 30	29	97	-
Unsuffixed n = 30	29	97	
Presence of Suffix II			
Suffixed n = 28	18	64	-
Unsuffixed n = 28	20	71	

Table 4.10.3 COMPREHENSION TESTS

Test	Number correct	Percentage correct
Semantic Probe n = 16	12	75

Table 4.10.4 TESTS OF NONWORD PROCESSING

Test	Number correct	Percentage correct	Significant effect of Variable
Reading aloud			
Easy Lexical Decision			
Words n = 25	25	100	+
Nonwords n = 25	8	32	
Reading by analogy I:			
Deletion			
Type A nonwords n = 15	10	67	-
Type B nonwords n = 20	11	58	
Reading by analogy II:			
Substitution			
Type A nonwords n = 12	6	43	-
Type B nonwords n = 12	8	57	
Pseudohomophony I			
Pseudohomophones n = 15	9	60	-
Non-pseudohomophones n = 15	9	60	
Reading aloud difficult lexical decision			
words n = 20	0	0	
Nonwords n = 20	0	0	
Inappropriately suffixed nonwords			
n = 25	13	52	

Table 4.10.5 READING ALOUD NONWORDS OF DIFFERENT STRUCTURE

Type	Example	Number correct	Percentage correct
A	tad	6	60
E	tood	4	40
F	dack	3	30
G	dunt	8	80

n = 10 in each list

Table 4.10.6 READING ALOUD WORDS AND NONWORDS OF DIFFERENT STRUCTURE

Type	Number of words correct	Percentage of nonwords correct
A	90	60
E	90	40
F	100	30
G	90	80

n = 10 in each list

Table 4.10.7 SILENT TESTS OF PHONOLOGY

Test	Number correct	Percentage correct
Silent test of phonology I		
Nonword n = 50	28	56
Regular word n = 50	41	82
Irregular word n = 50	37	74

Table 4.10.8 TESTS OF REPETITION ABILITY

Test	Number correct	Percentage correct
Pseudohomophony I		
Words n = 15	15	100
Nonwords n = 15	14	93
Easy lexical decision		
Words n = 25	24	96
Nonwords n = 25	22	88

Table 4.10.9 READING ERRORS: WORDS

		Number Correct	Percentage Correct
Visual		20	26
Sharing initial letter(s) with stimulus	7		
Sharing init. & fin. letter(s) with stimulus	8		
Sharing final letter(s) with stimulus	4		
Sharing medial letter(s) with stimulus	1		
Visual or Semantic		4	5
Derivational		7	9
Derivational or Inflectional (ing)		5	7
Inflectional		12	16
Nouns	8		
Verbs	4		
Function Word Substitutions			
Visually dissimilar		7	9
Other		21	28
Perseveration	1		
Visual and phonemic paraphasia	1		
Phonemic paraphasias	1		
Segmentation/blending	2		
Regularisation	1		
Regularisation	1		
Substitution, addition or deletion of word segments	8		
Incomplete	4		
Unclassified	2		
TOTAL ERRORS		76	
Words misread		65	9
Omissions		27	4
Words read correctly		612	87
TOTAL PRESENTED		704	
Corrections	7		
Addtional responses due to multiple attempts		4	

Table 4.10.10 READING ERRORS: NONWORDS

			Number Correct	Percentage Correct
Lexicalisations			40	60
Visually similar to stimulus	29			
sharing initial letter(s) with stimulus		15		
sharing init.and fin.letter(s) with stim.		10		
sharing final letter(s) with stimulus		2		
sharing letter(s) not in corresponding positions		2		
Visually distinct from stimulus	11			
sharing initial letter(s) with stimulus		5		
sharing final letter(s) with stimulus		1		
sharing medial letter(s) with stimulus		1		
sharing letter(s) not in corresponding positions		2		
sharing phoneme(s) but not letters with stimulus		2		
Incorrect nonwords			22	33
Mixed/multiple errors of grapheme-phoneme conversion		12		
Failure of marking function of silent _e_		1		
Substitution of single grapheme		3		
Addition of single grapheme		3		
Omission of single grapheme		2		
Sequency error		1		
Other			5	7
Literation		3		
Complete lexicalisation		2		
TOTAL ERRORS			67	
Total nonwords misread			45	39
Omissions			23	20
Total nonwords read correctly			47	41
TOTAL PRESENTED			115	
Corrections			5	
Additional errors due to multiple responses			17	

Table 4.10.11 TEXT READING ERRORS

	Number Correct	Percentage Correct
Errors on stem of content words (n = 56)	4	7
Derivational/inflectional errors on content words	2	
Errors on function words (n = 69)	3	4
TOTAL WORDS IN PASSAGE	125	

Fig. 4.10.1 Reading responses to words : FW

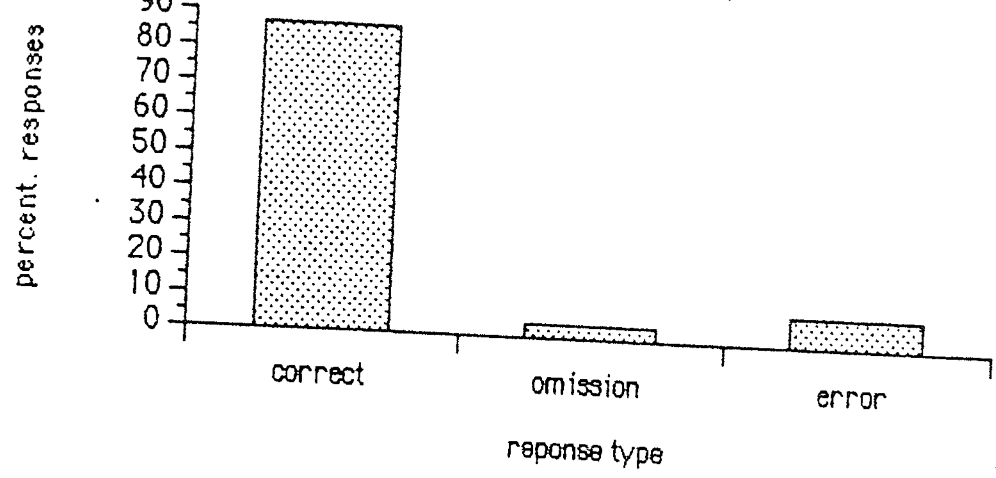


Fig. 4.10.2 Reading responses to nonwords : FW

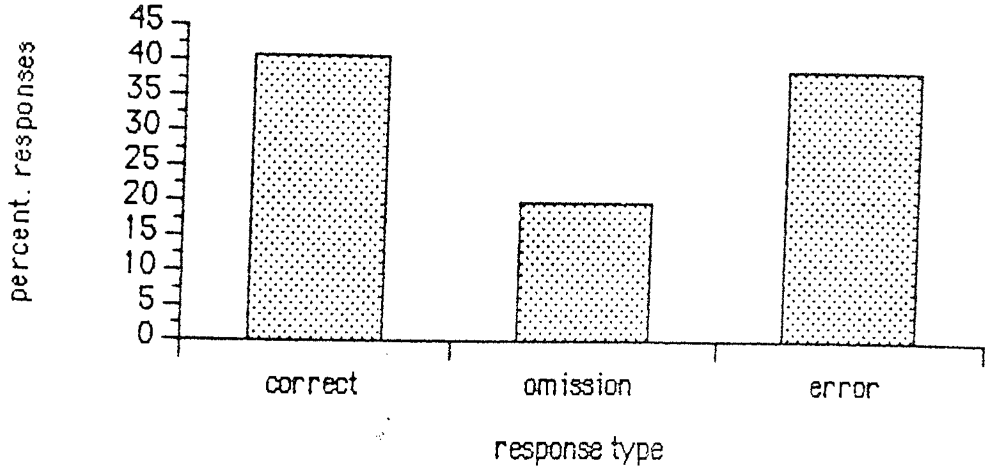


Fig.4.10.3 Types of error response to words : FW

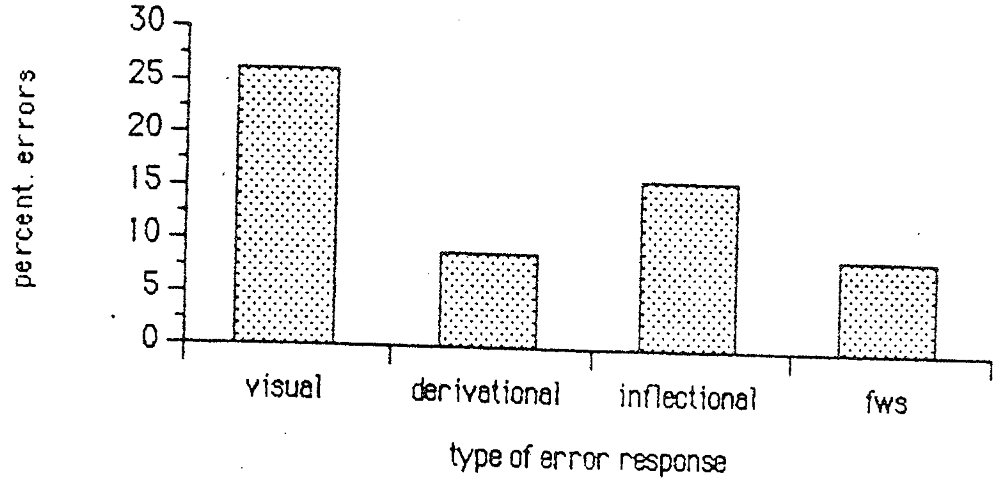
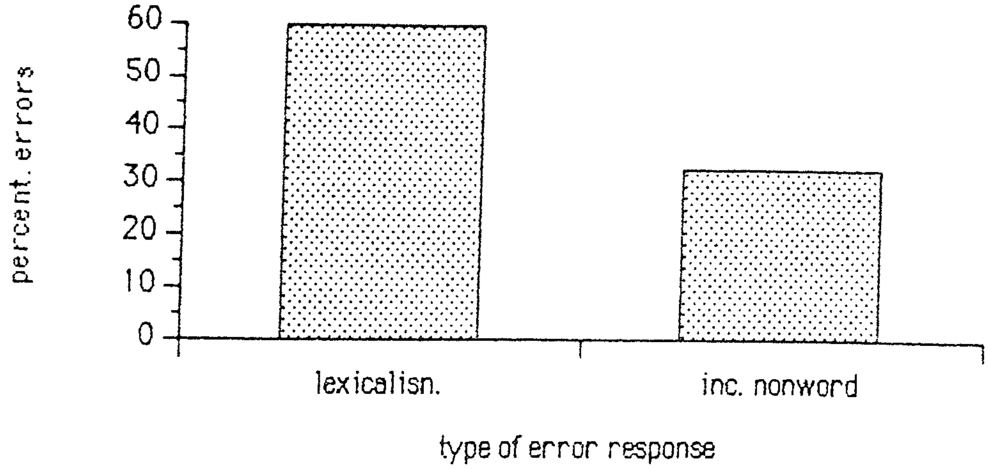


Fig.4.10.4 Types of error response to nonwords : FW



4.10.6 Analysis of test results

4.10.6.1 Reading at the single word level

There is no significant effect on performance of varying the Regularity of Spelling ($Z = 0$, $P > .05$) or the Frequency (full scores on both types of item) of the stimulus. There is no significant effect of the presence of a suffix (I: scores identical on both types of item; II: (X^2 (1df) = .3, $P > .05$). There is no effect of imageability in the Easy Test $Z = 0$, $P > .05$) but an effect of this variable is present in the Difficult Test (X^2 (1df) = 6.5, $P < .05$). There is no effect of Part of Speech in the Revised Test (X^2 (3df) = .59* $P > .05$) but an effect of this variable is present in the Easy Test (X^2 (3df) = 12.2*, $P < .05$). Although X^2 is inaccurate because of low expected values, its value is well above that at which significance at the 5% level is inferred and it is concluded that the significant effect of the variable is not an artefact in this case. Performance is 100% accurate in the Easy Lexical Decision Test. In the Difficult Test it drops dramatically and a Hit Rate of .05 and a False Alarm Rate of zero yield a d' of .68.

4.10.6.2 Tests of nonword processing

Words are read significantly better than nonwords in reading aloud Easy Lexical Decision (X^2 (1df) = 21.8, $P < .001$) and in the Words and Nonwords of Different Structure Test (X^2 (1df) = 16, $P < .001$). Performance on words and nonwords was at zero on reading aloud the Difficult Lexical Decision Test. There is no effect of pseudohomophony (scores identical on both types of item). There is no effect of type of item in the Reading by Analogy Tests (I: X^2 (1df) = .25, $P>.05$; II: X^2 (1df) = .57, $P>.05$). There is no significant difference between performance on Type E and Type F items ($Z = 0$, $P>.05$) or Type A and Type G items ($Z = .48$, $P>.05$). If scores on Type A and G (non-resegmentable) items are combined and compared with scores on Type E and F (resegmentable) items, the difference in scores is significant (X^2 (1df) = 4.9, $P<.05$). Performance is poor on all Silent Tests of Phonology, the lowest figure for d' being obtained on the Nonword Version (Nonword: Hit Rate .4, False Alarm Rate = .3, d' =.27; Regular Word: Hit Rate = .7, False Alarm Rate = .08, d' = 1.92; Irregular Word: Hit Rate = .6, False Alarm Rate = .2, d' = 1.1).

4.10.6.3 Tests of repetition ability

There is no significant difference between performance on words and nonwords in either test (Pseudohomophony I: $Z = 0$, $P>.05$; Easy Lexical Decision: $Z = .5$, $P>.05$).

4.10.6.4 Reading errors: Words

The highest proportion of errors (excluding those in the Other category) are visual (26% of total errors). When Derivational and Inflectional categories are combined however, these categories account for a slightly higher proportion (32%) of errors. There is no significant difference between the number of errors in the Visual and the number in the Derivational/Inflectional categories (X^2 (1df) = .36, $P>.05$). There is no significant difference between the number of errors in the Derivational and the number in the Inflectional category (X^2 (1df) = 1.3, $P > .05$).

4.10.6.5 **Reading errors: nonwords**

The highest proportion of errors (60%) are Lexicalisations. There are significantly more errors in this category than in the Incorrect Nonwords Category (X^2 (1df) = 5.2, $P < .05$). Significantly more lexicalisations are visually similar to the target than are visually distinct (X^2 (1df) = 8.1, $P < .01$).

4.10.6.6 **Reading errors: Text**

There is no significant difference between the number of errors made on the stems of content words and the number of errors made in response to function words in reading the passage of text ($Z = .28$, $P > .05$).

4.10.7 **Discussion of Reading Impairment**

4.10.7.1 **A note on tests administered**

Testing was not completed in this case. FW died in March, 1985. The data available is therefore limited and numerous tests of nonword processing were not administered. Not all types of item within the Structured Nonwords Test were given - the discussion of locus of impairment within the phonological roue is based on the reading of Type A, E, F and G items. Conclusions drawn in this case report are, therefore, often tentative. However, the word/nonword dissociation is very clear and the results of the Structured Nonwords Test show a distinctive pattern. The case report is therefore included in this study in spite of incomplete data.

4.10.7.2 Reliance on the lexical-semantic route for reading aloud

The synonym matching task was not administered to FW. The assumption that she relied on the lexical-semantic route for reading aloud single words is based on the presence of an imageability effect and a part of speech effect in which function words are read less efficiently than content words. Neither of these effects are unequivocally present, however and it may be that both direct and lexical-semantic routes are functional. The facilitatory effect of imageability on performance occurs only in the Difficult Test. This may be due to good performance in the Easy Test producing a ceiling effect. More difficult to explain is the presence of a function word deficit in the Easy but not in the Revised Part of Speech Test. All 3 errors in the Revised Test and 3/6 errors in the Easy Test are visually similar function word substitutions. The remaining errors comprise 1 unclassified error and 2 errors of segmentation/blending (e.g. along → /æ - lɒŋ/. The assumption that there is a genuine difficulty in reading aloud function words is supported by FW's subjective report that "I get mixed up with / θ/ words". This statement was made when, after much hesitation, she read a function word correctly. It may be that if response latencies had been recorded both for words in isolation and in text, an effect would have been found in all tests. Further testing would have enabled the presence of these effects to be confirmed or disconfirmed and a comparison of reading and comprehension performance to be made. In the comprehension tests involving single written stimuli which were administered (BDAE word-picture matching and semantic probe) FW's performance was good; she scored 100% in both tests.

4.10.7.3 Derivational and Inflectional errors

Errors in these combined categories account for 32% of total errors, this proportion being higher than that classified as visual. Yet there is no effect of the Presence of a Suffix in either test of this variable. Responses to inappropriately suffixed words show no consistent pattern, errors occur on stem (e.g. happenly -> /ˈhæpɩŋli/, affix (e.g. colded -> / ˈkoʊldəz /, or both (e.g. supportest -> / ˈsʌpɒs /. FW did not read inappropriately suffixed words more efficiently than other nonwords.

The high proportion of derivational and inflectional errors suggests that these errors do form a genuine category of error. The lack of effect of the presence of a suffix suggests that they do not and there is no significant diffrence between the number of derivational and the number of inflectional errors which is compatible with these errors being visual in origin. No firm conclusion regarding this type of error can be drawn in this case.

4.10.7.4 The nonword reading impairment

4.10.7.4.1 General comments

There is a clear dissociation between word reading (100% and 93% correct) and nonword reading (32% and 53% correct). Good repetition ability whether stimuli are words or nonwords and particularly poor performance on the Nonword version of the Silent Test of Phonology indicate that the problem is not due to difficulty in articulating unfamiliar items. There is no effect of Pseudohomophony or of stimulus type in the Reading by Analogy tests. The majory (60%) of error responses to nonwords are lexicalisations. Only 10/22 errors which are Incorrect Nonwords contain minimal errors of grapheme-phoneme conversion involving a single error. The remainder of this type of error involve more serious errors of grapheme-phoneme conversion. Nevertheless, 41% of nonwords which were read correctly and the small number of errors which result from minor misconversions indicate that it is possible to obtain output from the phonological route.

4.10.7.4.2 The locus of impairment within the phonological route

The only test administered to FW which bears on this issue other than performance in the Structured Nonwords Test, is the test of Letter Sounding (although as noted in earlier discussion, this ability can dissociate from the ability to read nonwords aloud). FW was able to sound only 4/24 (17%) of visually-presented letters.

The complete Structured Nonwords Test was not administered.. Items comprising the first half of Lists A, E, F and G were administered (40 items in all). FW read 53% of these nonwords correctly. Items in List E (e.g. tood) and F (e.g. duck) require resegmentation. Items in List A (e.g. tad) and G (e.g. dunt) do not. There is no significant difference between performance on Type E and Type F nonwords which would suggest problems with phoneme allocation. There is no significant difference between performance on Type A and Type G nonwords which would suggest difficulty with blending. If the scores on items requiring resegmentation (E and F) are combined and the scores on non-resegmentable iems (A and G) are combined, there is a significant difference between performance on the 2 types of item. Nonwords requiring resegmentation are read less well than those which do not require resegmentation. Thus the Resegmentation System is implicated as the major locus of impairment within the phonological route. Errors on items which require resegmentation comprise 46% lexicalisations and 54% incorrect nonwords. Of the errors classified as incorrect nonwords 57% involve misconversion of the digraph, a pattern which provides some support for the hypothesised locus of impairment.

4.10.8 Summary

FW presents with a phonological dyslexia in which nonword reading is impaired but not totally abolished. Results of nonword reading tests indicate that the Resegmentation System is the major locus of impairment within the phonological route. There is an effect of imageability on word reading which suggests that FW relies on the lexical-semantic route for reading aloud.

4.11 Case Report IX: WPB

4.11.1 Neurological Background

WPB is an 80-year old right-handed man who sustained a CVA in June, 1981. He was admitted to the Good Hope Hospital because of the sudden onset of garbled speech. Dementia was initially suspected; the diagnosis of CVA was adopted on the basis of behavioural characteristics and especially in view of the sudden onset of the language disorder. There is no information regarding the site of lesion. The aphasia which was present immediately post-trauma has now resolved. There is a slight loss of hearing acuity in the right ear. A mild acalculia is present. In the supplementary tests provided with the BDAE (Goodglass and Kaplan, 1983) WPB scored 4/8 on addition, 7/8 on subtraction, 3/7 on multiplication and 2/9 on division. Failure in addition occurred when more than 2 numbers were to be added. He was clearly aware of the algorithm by which each of the arithmetical operations is performed; failure was due to slips in calculation rather than to lack of knowledge of procedures. In view of the fact that WPB is trained in book-keeping, these are, however, low scores. A tendency to confuse dates and phone numbers remains, but WPB is otherwise an alert, intelligent and well-orientated man.

4.11.2 Educational and Occupational Background

WPB received 9 years full-time schooling followed by 2 years attendance at night school, learning economics and book-keeping. At the time of his retirement he worked as a Quality Control Inspector for the Egg Marketing Board. He was also secretary of the local branch of the Commercial Travellers' Association which entailed a fair amount of paperwork. He describes office work as his hobby. WPB is interested in music and travel at home and abroad and has continued to attend concerts and to take holidays since his CVA.

4.11.3 Aphasia and dysgraphia

The jargon aphasia with which WPB presented immediately post-trauma resolved after a short period. There is no evidence of aphasia in conversational speech. The following example of spontaneous speech was elicited by a request to describe the "Cookie Theft" picture in the BDAE. It illustrates WPB's perceptive and humorous approach to language tasks.

"The kid's falling off the stool and going to break his neck for a start, and the water's going all over the floor down here. I think the little girl's laughing because the kid can't get the biscuits out of the tin. You'd think she'd take her feet out of the water. I've told her to turn the tap off - she's still doing it! She's holding the cloth oddly too.

"Not a lot to see outside. There's a garden and so on. I suppose the fact that he's being greedy - grabbing one with one hand and one with the other isn't important. This line here doesn't seem right - it doesn't go across and join up behind her. I like a picture to get things right."

Scores on the BDAE are high. There is a slight impairment of auditory comprehension revealed by scores in the Body Part Naming and Complex Ideational Material subtests although scores in both subtests are above the 80th percentile. Confrontation naming is also very slightly impaired and 1 error was made on the repetition of low-probability items. Scores on reading and writing subtests show more evidence of impairment. Oral reading is good at the single word level but impaired when stimuli form sentences. Comprehension of sentences and paragraphs is also impaired as is comprehension of oral spelling and WPB is unable to write sentences to dictation.

There is moderate dysgraphia present. WPB wrote correctly 69% of single words dictated to him. There is no significant difference between his score on writing simple high-frequency words (9/10) and his score on writing matched nonwords (5/10).

4.11.4 Neuropsychological Baseline Tests

WPB has a Memory Quotient of 116 on the Wechsler Memory Scale. His digit span is 7 forward and 2 backward. A score of 25.5/36 on the Token Test indicates a mild impairment of auditory comprehension when this depends upon the comprehension of prepositional relations. He has an I.Q. equivalent of 129 on the spoken and 133 on the written version of the PPVT and scored 55/60 on the extended Boston Naming Test.

4.11.5 Reading and repetition tests

The results of reading and repetition tests are shown in Tables 4.11.1 to 4.11.9. A transcription of WPB's reading of the passage of text is provided in Appendix II. Error types are shown in Tables 4.11.10 to 4.11.12. Figure 4.11.1 shows the effect of word length on reading speed. Proportions of errors falling into the main error categories and proportions of different types of response are shown graphically in Figures 4.11.2 to 4.11.5.

Table 4.11.1 READING AT THE SINGLE LETTER LEVEL

Test		Number Correct	Percentage Correct
Single letter naming	n = 26	25	96
Single letter sounding	n = 24	0	0
Single letters from a string	n = 20	24	92
Cross-case letter matching	n = 58	58	100

Table 4.11.2 READING AT THE SINGLE WORD LEVEL

Test	Number Correct	Percentage Correct	Significant effect of Variable
Easy lexical decision n = 50	48	96	
Difficult lexical decision n = 40	32	80	
Imageability (standard)			
High Imageable n = 20	20	100	-
Low Imageable n = 20	20	100	
Imageability (difficult)			
High Imageable n = 20	16	80	-
Low Imageable n = 20	20	100	
Part of speech (easy)			
Noun n = 20	20	100	-
Verb n = 20	20	100	
Adjective n = 20	20	100	
Function word n = 20	20	100	
Part of speech (difficult)			
Noun n = 18	18	90	-
Verb n = 20	20	100	
Adjective n = 17	17	85	
Function word n = 17	17	85	
Part of speech (revised)			
Noun n = 25	23	92	-
Verb n = 23	22	96	
Adjective n = 25	25	100	
Function word n = 37	35	95	
Regularity of spelling (standard)			
Regular n = 39	39	100	-
Irregular n = 39	39	100	
Regularity of spelling (difficult)			
Regular n = 20	20	100	-
Irregular n = 20	17	85	
Frequency			
High Frequency n = 23	23	100	-
Low Frequency n = 23	22	96	
Word length			
3-letter n = 10	10	100	-
4-letter n = 10	9	90	
5-letter n = 10	10	100	
6-letter n = 10	10	100	
7-letter n = 10	9	90	
8-letter n = 10	9	90	

Table 4.11.2 READING AT THE SINGLE WORD LEVEL (continued)

Test	Number Correct	Percentage Correct	Significant effect of Variable
Presence of Suffix I			
Suffixed n = 30	28	93	
Unsuffixed n = 30	29	97	
Presence of Suffix II			
Suffixed n = 28	25	89	
Unsuffixed n = 28	28	100	

Table 4.11.3 COMPREHENSION TESTS

Test	Number correct	Percentage correct
Synonym matching		
High Imageable n = 38	37	97
Low Imageable n = 38	31	82
Semantic Probe n = 16	14	88
Comprehension of functors n = 18	17	94

Table 4.11.4 TEST OF MORPHOLOGICAL KNOWLEDGE

Test	Number correct	Percentage correct
Single word test n = 32	29	91

Table 4.11.5 TESTS OF NONWORD PROCESSING

Test	Number correct	Percentage correct	Significant effect of Variable
Reading aloud			
Easy Lexical Decision			
Words n = 25	25	100	+
Nonwords n = 25	15	60	
Nonwords with inconsistent letters			
With inconsistent letter n = 36	22	61	-
Without inconsistent letter n= 36	22	61	
Nonwords synthesised from words			
with colour cue n = 10	7	70	-
without colour cue n = 10	2	20	
Segmentable words			
Visual mode n = 30	29	97	-
Auditory mode n = 30	27	90	
Hidden words n = 20	19	95	
Sound Blending I			
Words n = 24	3	13	-
Nonwords n = 8	0	0	
Sound Blending II n = 40	17	43	
Consistent and Inconsistent nonwords			
With consistent segment n = 15	5	33	-
With inconsistent segment n = 15	7	47	
Reading by analogy I: Deletion			
Type A nonwords n = 15	6	40	-
Type B nonwords n = 20	8	40	
Reading by analogy II: Substitution			
Type A nonwords n = 14	6	43	-
Type B nonwords n = 12	8	57	
Pseudohomophony I			
Pseudohomophones n = 15	8	53	-
Non-pseudohomophones n = 15	10	67	
Pseudohomophony II			
Pseudohomophones n = 10	6	60	-
Non-pseudohomophones n = 10	5	50	
Reading aloud difficult lexical decision			
Words n = 20	13	65	+
Nonwords n = 20	1	5	

Table 4.11.5 TESTS OF NONWORD PROCESSING (continued)

Test	Number correct	Percentage correct	Significant effect of Variable
Inappropriately suffixed nonwords n = 25	20	80	
Affixes in isolation n = 10	6	60	

Table 4.11.6 READING ALOUD NONWORDS OF DIFFERENT STRUCTURE

Type	Example	Number correct	Percentage correct
A	tad	16	80
B	ank	15	75
C	ead	10	50
D	eth	12	60
E	tood	15	60
F	dack	12	60
G	dunt	15	75
H	afe	14	70

n = 20 in each list

Table 4.11.7 READING ALOUD WORDS AND NONWORDS OF DIFFERENT STRUCTURE

Type	Percentage of words correct	Percentage of nonwords correct
A	100	90
E	100	50
F	90	70
G	100	90

n = 10 in each list

Table 4.11.8 SILENT TESTS OF PHONOLOGY

Test	Number correct	Percentage correct
Silent test of phonology I		
Nonword n = 50	27	54
Regular word n = 50	34	68
Irregular word n = 50	32	64
Silent test of phonology II n = 40	22	55

Table 4.11.9 TESTS OF REPETITION ABILITY

Test	Number correct	Percentage correct
Pseudohomophony I		
Words n = 15	12	80
Nonwords n = 15	11	73
Easy lexical decision		
Words n = 25	25	100
Nonwords n = 25	23	92
Nonwords of different structure		
Type A n = 10	8	80
Type B n = 10	7	70
Type C n = 10	8	80
Type D n = 10	8	80
Type E n = 10	7	70
Type F n = 10	9	90
Type G n = 10	6	60

Table 4.11.10 READING ERRORS - WORDS

		Number of errors	Percentage of errors
Visual		23	47
Sharing initial letter(s) with stimulus	9		
Sharing init. & fin. letter(s) with stimulus	13		
Sharing medial letter(s) with stimulus	1		
Derivational		8	16
Inflectional			
Nouns	1	1	2
Function Word Substitutions			
Visually similar	3	3	6
Other		14	29
Completion	1		
Inappropriate suffixes	3		
Regularisation	1		
Complex function word substitution	1		
TOTAL ERRORS		49	
Words misread		40	4
Omissions		0	0
Words read correctly		920	96
TOTAL PRESENTED		960	

Error responses corrected 9

Table 4.11.11 READING ERRORS NONWORDS

			Number of errors	Percentage of errors
Lexicalisations				
Visually similar to stimulus	76		82	52
sharing initial letter(s) with stimulus		15		
sharing init. & fin.letter(s) with stimulus		22		
sharing final letter(s) with stimulus		35		
sharing medial letter(s) with stimulus		2		
sharing letters not in corresponding posns.		2		
Visually distinct from stimulus	6			
sharing initial letter(s) with stimulus		4		
sharing final letter(s) with stimulus		2		
Incorrect nonwords			76	48
gross/multiple errors of grapheme-phoneme conversion		30		
substitution, addition, or omission of of word segments		12		
phonemic realisation of silent _e_		2		
failure of marking function of silent _e_		1		
addition of single grapheme phoneme		14		
omission of single grapheme/phoneme		2		
substitution of single grapheme/phoneme		14		
segmentation plus misconversion		1		
TOTAL ERRORS			158	
Nonwords misread			149	42
Omissions			1	0
Nonwords read correctly			207	58
TOTAL PRESENTED			357	

Corrections	5
Additional errors due to multiple responses	4

Table 4.11.12 TEXT READING ERRORS

	Number of errors	Percentage of errors
Errors on stem of content words (n = 56)	5	9
Derivational/inflectional errors on content words	2	
Errors on function words (n = 69)	5	7
TOTAL WORDS IN PASSAGE	125	

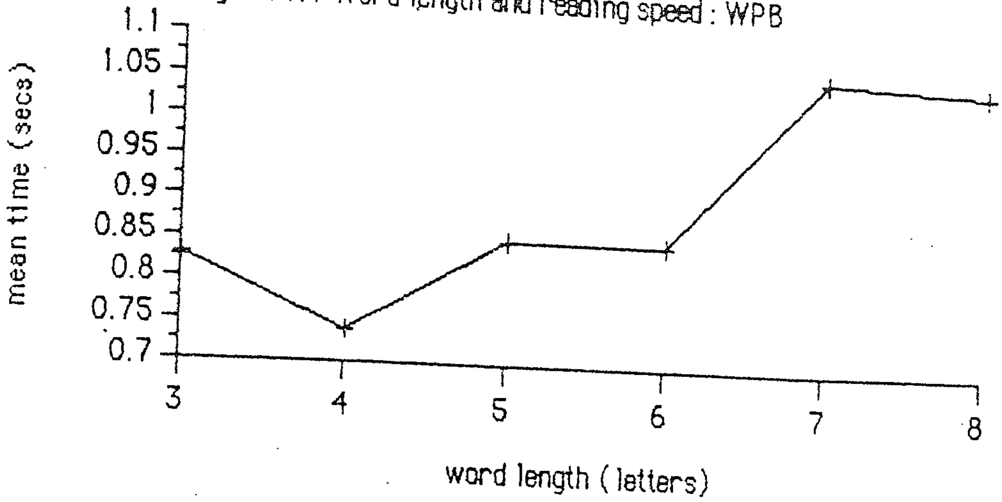


Fig. 4.11.1 Word length and reading speed : WPB

Fig. 4.11.2 Reading responses to words : WPB

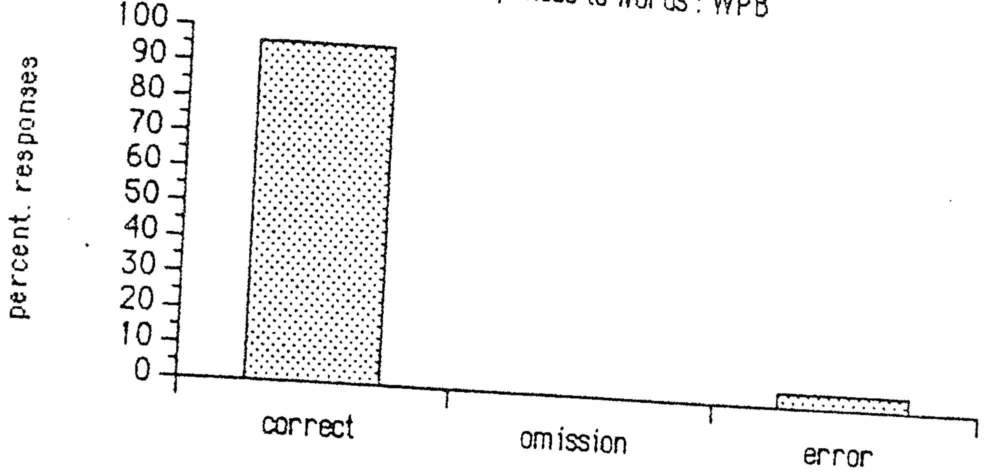


Fig. 4.11.3 Reading responses to nonwords : WPB

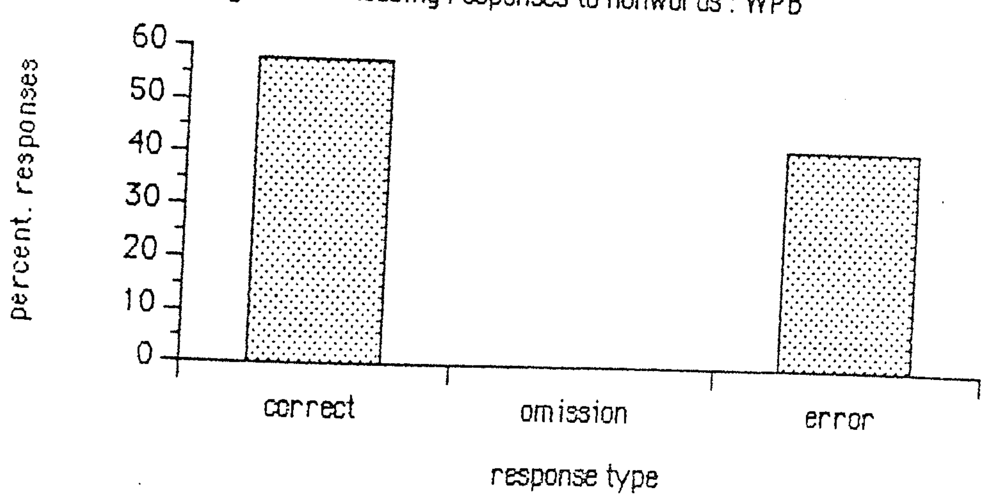


Fig.4.11.4 Types of error response to words : WPB

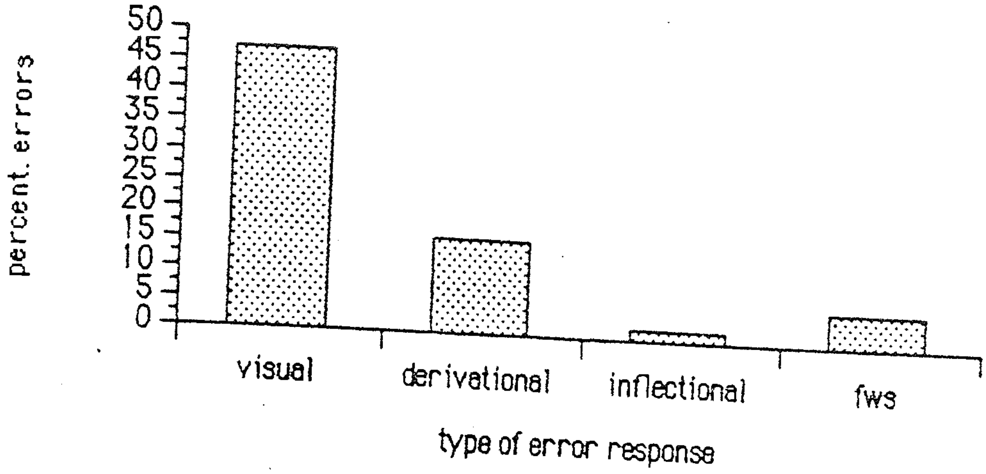
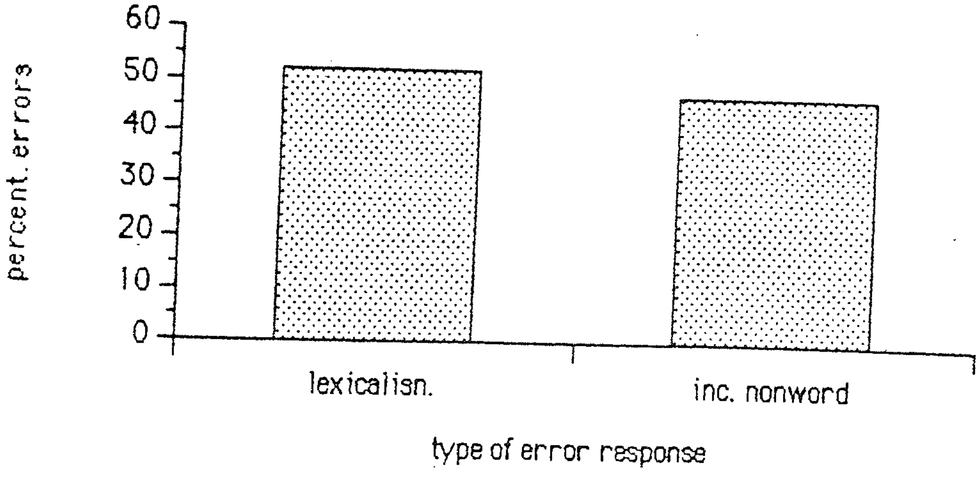


Fig.4.11.5 Types of error response to nonwords : WPB



4.11.6 Analysis test results.

4.11.6.1 Reading at the Single Word Level

There is no significant effect on performance of varying imageability (Standard: scores equal on both types of item; Difficult: Z = 1.6, $P > .05$), Part of Speech (Easy: scores equal on all types of item; Difficult: X^2 (3df) = 3.3*, $P > .05$; Revised: X^2 (3df) = 1.9*, $P > .05$), Regularity of Spelling (Standard: scores equal on both types of items; Difficult: Z = 1.2, $P > .05$), Frequency (Z = 0, $P > .05$; or Word Length (Accuracy: Kendall's S = -5, $P > .05$; Speed: Kendall's S = 10, $P > .05$). There is no significant effect of the presence of a suffix (I: Z = 0, $P > .05$; II: Z = 1.2, $P > .05$). The lexical decision score is higher on the Easy (Hit Rate = .96,False Alarm Rate = .04, d' = 4.07) than on the Difficult Test (Hit Rate = .8, False Alarm Rate = .2, d' = 1.68).

4.11.6.2 Tests of comprehension and morphological knowledge

There is a significant effect of imageability in the matching (Z = 1.9, $P < .05$) but not in the reading (Z = 0, $P > .05$) task. The overall score on the reading task is significantly higher than the overall score on the matching task (Z = 2, $P < .05$). WPB's score on the Semantic Probe Test is above chance (chance = 8 ± 4) as is his score on the Comprehension of Functors Test (Chance = 9 ± 3). Performance is moderately good on the Single Word Test of Morphological Knowledge (Hit Rate = .9, False Alarm Rate = .06, d' = 2.83).

4.11.6.3 Tests of nonword processing

Words are read significantly better than nonwords in Reading Aloud Easy Lexical Decision (X^2 (1df) = 12.5, $P<.001$), Reading Aloud Difficult Lexical Decision (X^2 (1df) = 15.8, $P<.001$) and in the Words and Nonwords of Different Structure Test (X^2 (1df) = 8.5, $P<.01$). Nonwords synthesised from words are read significantly better with than without a colour cue (Z (1-tail) = 1.8, $P<.05$). There is no effect of the presence of an inconsistent letter (equal scores on both types of item) or an inconsistent segment (X^2 (1df) = .6, $P>.05$). There is no effect of pseudohomophony (I: X^2 (1df) = .6, $P>.05$; II: X^2 (1df) = .2, $P>.05$). There is no effect of type of item in the Reading by Analogy Tests (I: X^2 (1df) = 0, $P>.05$); II: X^2 (1df) = .6, $P>.05$). There is no significance between scores in the different modalities in the Segmentable Words Test (Z = .5, $P>.05$) nor between scores on words and nonwords in the Sound Blending I Test (Z = .3, $P>.05$). There is no overall effect of type of item in the Structured Nonwords Test (X^2 (7df) = 6.6, $P>.05$). There is no significant difference between Type C combined with Type E and Type D combined with Type F items (X^2 (1df) = .2, $P>.05$). If resegmentable items are grouped together (Types C, D, E and F) and non-resegmentable items (Types A, B and G) are grouped together, significantly more items in the latter than the former group are read correctly (X^2 (1df) = 5.6, $P<.05$). There is no significant difference between scores on Type A items and Type B and G items (Z = .1, $P>.05$). Performance is most severely impaired in the Nonword Version of the Silent Test of Phonology I (Nonword: Hit Rate = .6, False Alarm Rate = .5, d' = .26;

Regular Word: Hit Rate = .7, False Alarm Rate = .4, d' = .78; Irregular Word: Hit Rate = .6, False Alarm Rate = .4, d' = .51). In the Silent Test of Phonology II, a Hit Rate of .7 and a False Alarm Rate of .6 yield a d' of .27.

4.11.6.4 Tests of repetition ability

There is no significant difference between performance on words and nonwords in either test (Pseudohomophony I: Z = 0, $P>.05$; Easy Lexical Decision: Z = .7, $P>.05$). There is no effect of type of item in the repetition of nonwords of different structure (X^2 (6df) = 3.1, $P>.05$). There is no significant difference between total scores on reading and repetition in the Pseudohomophony I Test X^2 (1df) = 1.9, $P>.05$). In the Easy Lexical Decision Test and the Structured Nonwords Test, repetition scores are higher than reading scores. (Easy Lexical Decision: X^2 (1df) = 7, $P<.01$; Structured Nonwords: X^2 (1df) = 6.1, $P<.05$).

4.11.6.5 Reading errors: Words

The highest proportion (47%) of errors are visual. There are significantly more errors in this category than in the combined Derivational and Inflectional categories (X^2 (1df) = 6.1, $P<.05$). There are significantly more errors in the Derivational than in the Inflectional category (X^2 (1df) = 5.4*, $P<.05$).

4.11.6.6 Reading errors: Nonwords

The highest proportion (52%) of errors are lexicalisations. There is no significant difference between the number of errors in this category and the number of errors classified as Incorrect nonwords which account for the remaining 48% of errors (X^2 (1df) = .23, P> .05). Significantly more lexicalisations are visually similar to the stimulus than are visually distinct (X^2 (1df) = 59.8, P<.001). There is no significant difference between the proportion of incorrect nonwords which involve the misconversion of a single grapheme and the proportion which involve mixed or multiple misconversions (X^2 (1df) = .14, P>.05).

4.11.6.7 Reading Errors: Text

There is no significant difference between the number of errors made on the stem of content words and the number made in response to function words (Z = .01, P>.05).

4.11.7 Discussion of Reading Impairment

4.11.7.1 Reliance on the direct route for reading aloud

WPB's scores on reading and comprehension tasks are high and there is no effect of imageability on reading aloud. There is, however, a significant effect of imageability on comprehension in the synonym matching task. There is no such effect in the reading aloud of the items from this test. The overall score on the reading task is significantly higher than the overall score on the matching task. This discrepancy suggests that WPB is able to use the direct route for reading aloud. The caveat which has been mentioned earlier regarding the possible use of residual phonological abilities for word reading mentioned in earlier reports (e.g. TW, Case Report III) applies here. Since WPB's overall nonword reading score is much higher than TW's (WPB read 58% nonwords) there is far more likelihood of involvement of the phonological route in this case. WPB's performance on reading long nonwords makes involvement of this route unlikely, however. WPB had no difficulty in reading aloud long words like <u>hopelessness</u> and <u>ridicule</u> (while matching errors occurred on these words) but was able to read aloud only 1/20 nonword items from the difficult lexical decision task. As an additional check, WPB was asked to define the irregularly spelled words (which cannot be read correctly via the phonological route) from the Difficult Regularity Test. His instructions were to read aloud each item presented and then to define it. WPB has no difficulty with verbal definition; his aphasic impairments are minimal. He showed a degree of consistency on this test; reading errors occurred on the same 3 items as had been misread in the original administration of the test. In one case, the error response was identical on both occasions (<u>psychosis</u> -> / 'sakɒsɪs /). Errors on the two other items differed from the original response (1st administration: <u>chronicle</u> -> "chronic": concerto -> / 'kɒnsɜtoʊ/ /; 2nd administration: <u>chronicle</u> -> "chronological", concerto -> "concert"). Thus WPB read aloud 17/20 items. He defined only 14/20. This difference is suggestive but does not reach significance (Z = 1.12, P>.05). Items which he failed to define are: <u>memoir</u> -> "Is it a painting?"; <u>poultice</u> -> "Something to do with hens"; concerto → "Entertainment, playing any sort of music"; bourgeois → "Don't know. It's French isn't it?"; chronicle → "A bad case, going on and on"; psychosis → "Don't know. Sounds foreign." The evidence thus strongly suggests reliance on the direct route.

4.11.7.2 The morphological decomposition system

In cases where the direct route is shown to be functional, the pattern of reading errors becomes relevant to the question of the locus of the morphological decomposition system. The alternatives (discussed in Chapter 1) are a) that the system is located within the lexical-semantic route following visual word recognition or b) that the visual word recognition system is morpheme-based. The most relevant aspects of reading behaviour with respect to this issue are the occurrence of derivational and inflectional errors and the effect of the presence of a suffix on reading behaviour. In this case, there is no effect of the presence of a suffix and the number of errors classified as derivational and inflectional is very low (8 and 1 respectively). However, because the overall error rate is low, these error categories account for 18% of errors. Significantly more errors are classified as derivational than are classified as inflectional. The latter observation provides some evidence for the assumption that these errors form a genuine error category since if they are in fact visual errors, there is no reason why the proportion classified as derivational and the proportion classified as inflectional should differ. On the other hand, where the absolute number of errors in the categories is so low, some doubt as to whether they are genuine error categories in this case must remain, especially in view of the lack of an effect of the presence of a suffix. WPB's good performance (80% correct in comparison with an overall score of 58% on nonword reading) on the Inappropriately Suffixed Nonwords Test provides some evidence for a recognition system which deals separately with stems and affixes. The affix was retained in 3 of his 5 errors in this test; 1 of these responses formed a word (brighted -> "brightening"), the others did not (e.g. darking -> "/'dakliŋ /). In the remaining 2 errors, the affix was substituted so that there is no consistent pattern of errors. In spite of the high score on this test, WPB read only 60% of affixes in isolation. This score is at the level of overall nonword reading and does not support Job and Sartori's (1984) suggestion (see Chapter 1) regarding independent affix recognisers. WPB's pattern of errors is compatible with a morpheme-based visual word recognition system but does not provide clear evidence to support the proposal that the system is morpheme-based.

4.11.7.3 The nonword reading impairment

4.11.7.3.1 General comments

WPB is the least impaired of the patients discussed in this work in his ability to read aloud nonword stimuli. His overall success rate is 58%. A high proportion (48%) of his errors are incorrect nonwords and 43% of these errors involve the misconversion of a single grapheme. The nature of the error responses and the relatively high nonword reading level, indicate that the phonological route is operative though impaired.

4.11.7.3.2 The locus of impairment within the phonological route: Nonwords of Different Structure Test

WPB read correctly 66% of items in this test. There is no overall effect of type of item. There is no significant difference between scores on items containing a vowel digraph (Type C and E) and items containing a consonant cluster (Type D and F). However, when scores on items which require resegmentation (Types C, D, E and F) are aggregated and compared with aggregated scores on items which do not require resegmentation (Types A, B and G), significantly more items which do not require resegmentation are read correctly. Type H items are excluded from this reanalysis since a different type of resegmentation process may be involved in the translation of nonwords containing a silent e (see Chapter 3, Section 3.1.5.2.3.2). Error analysis does not reveal any significant difference between error types within the two groups (X^2 (1df) = .2, P .05). In the group of items which do not require resegmentation 64% of responses were lexicalisation and 36% were incorrect nonwords. In the group of items requiring resegmentation, 58% of responses were lexicalisations and 42% were nonwords. A single omission occurred in response to a Type E item (taum). WPB commented, when presented with this item, "These are the awkward ones you know". In the group of items requiring resegmentation 46% of the error responses which are incorrect nonwords involve an error on the digraph (e.g. yeed -> / jɛd /; shen -> / ʃɛn / while the remaining 54% of errors involve another grapheme (e.g. feep -> / frip /; thip -> / θrɪp/.

4.11.7.3.3 The locus of impairment within the phonological route: additional evidence

4.11.7.3.3.1 The resegmentation system

WPB performed very well on the tests which require resegmentation without nonword reading (segmentable words and hidden words). There is no significant difference between scores on the auditory and visual versions of the segmentable words test and it is therefore possible that WPB was performing the task by means of segmentation of an auditory representation. However, not all items in this test lend themselves to the use of this strategy (see Chapter 3, Section 3.1.5.6), These test results do not provide supportive evidence for the proposed locus of impairment. However, as noted in Chapter 3 (Section 3.1.5.6), these tasks do not necessarily involve the resegmentation system within the phonological route and it is to be expected that the ability to perform these tasks and the ability to resegment a nonword stimulus in the course of reading it aloud will dissociate. WPB's good performance on these tasks does not therefore serve to disconfirm the claim that the resegmentation system is impaired. Patterson and Marcel (Note 1.3) administered their orthographic segmentation tasks to WPB. He obtained a high score in the task in which common letters in words must be underlined (98% correct). He was less efficient in their second orthographic task involving the identification of one or two letters in a letter string which, when inserted into a gap in a second letter-string make it a word. He was much more competent in this task when 2 letters were involved (76% when letters corresponded to a grapheme; 84% when they did not) than when one letter was involved (52% correct). I shall not here discuss Patterson and Marcel's interpretation of the results (their paper is in preparation) but note that WPB's performance on these tasks indicates some impairment of the Resegmentation System.

4.11.7.3.3.2 The Phoneme Allocation System

The lack of an effect of the presence of an inconsistent letter provides additional evidence that the Phoneme Allocation system is not the major locus of impairment. It is interesting to note that, in spite of his relatively good nonword reading ability, WPB was unable to sound any visually presented letters of the alphabet. He was asked to perform this task 4 times and on each occasion stated emphatically that he could not perform it. He claimed that he had never learned letter sounds at school. This is probably true but it is unlikely that normal readers are able to give letter sounds only if they have been taught grapheme-phoneme correspondences explicity. Furthermore WPB was asked to repeat letter sounds on several occasions which he was able to do reasonably efficiently (21/24 correct), and in the absence of a specific impairment in the reading system, should surely have learned the correspondences. An attempt was made to elicit phonemic realisaions of letters by asking WPB to sound the first letters of words[1] presented to him auditorily and visually. He was not able to perform either of these tasks. He was unable to produce any responses in either task, even when pressed for a response. He had no difficulty in naming letters presented in isolation (96% correct) in a nonword string (92% correct) or in the words used in the above-mentioned phonemic segmentation task (96%).

The dissociation between letter sounding and nonword reading abilities has been reported by Funnell (1983). Funnell argues that the dissociation suggests that the reading aloud of nonwords in such cases, is not achieved "via translation processes based on single letters" since, if it were, "procedures should also be available for the processing of letters presented in isolation." An alternative account of the dissociation is proposed in Chapter 1, Section 1.3.1.2.1.4). It is concluded that there is a separate store containing the syllabic sounds corresponding to individual letters, while pure phonemes are stored in the phoneme allocation system. It is also of note that CB (Case Report IV) is able to sound letters efficiently while reading only 42% of nonwords correctly, a much lower proportion than that read by WPB.

4.11.7.3.3.3 **The Blender**

Performance on auditory sound blending tasks indicates impairment of the ability to blend auditorily-presented phonemes into a whole. Performance on the Sound Blending I Test is poor, regardless of whether items to be blended are words (13% correct) or nonwords (zero score). Performance on the Sound Blending II Test, which does not include items above 4 phonemes in length, was somewhat better (43% correct) although still indicative of impairment. These scores suggest that the Blender as well as the Resegmentation System is impaired. Since the score on the Nonword Auditory Sound Blending Test (43%) is lower than the overall nonword reading score (58%) it would appear that there are additional demands involved in blending auditorily-presented phonemes which render this task more difficult than the task of blending the phonemes output from the Phoneme Allocation System. WPB is able to blend words to form longer nonwords. In the Nonwords Synthesised from Words Test he read 70% of nonwords correctly when a colour cue was provided. The presence of a colour cue has a facilitatory effect on performance.

4.11.8 Summary

WPB presents with a phonological dyslexia in which nonword reading is impaired but not totally abolished. The results of the Structured Nonwords Reading Test suggest that the Resegmentation System is the primary locus of impairment within the phonological route. There is evidence that WPB relies on the direct route for reading words aloud.

Notes on Case Report IX

1 The words used in this task were:

ant, box, car, dog, egg, fan, got, hut, inn, jab, kid, lid,man, nod, off, pan, rod, sit, top, up, vow, wit, yes, zoo.

4.12 Case Report X: IC - A cautionary tale

4.12.1 Introduction

The data collected from IC is incomplete due to limited testing time. Therefore results can only be regarded as suggestive of certain conclusions and not as firm evidence for any hypothesis. Furthermore IC is not a phonological dyslexic although the results of preliminary testing suggested that she was[1]. The necessarily brief case report is included because of the interesting observation that although there is no evidence to suggest that IC cannot assemble phonology (although she has difficulty in articulating unfamiliar phonological representations) her word reading performance shows some of the characteristics often associated with phonological dyslexia. These charateristics are:

i) the occurrence of visual, derivational, inflectional and possibly semantic errors and function word substitutions, and

ii) sensitivity to the imageability of the stimulus.

The presence of the various error types is not unequivocal. As will be explained later, the majority of the errors thus classified may be susceptible of alternative explanations. The imageability effect is, however, robust and does not disappear when errors which appear to result from IC's overall articulatory difficulties are counted as correct. An imageability effect is not however observable in the repetition of high and low imageable stimuli.

The case illustrates the value of including tests of pseudohomophony and silent tests of phonology in the test battery administered to suspected cases of phonological dyslexia.

4.12.2 Case Report

4.12.2.1 Neurological, Educational and Occupational Background

IC is a 70-year old right-handed woman who sustained a CVA, which was preceded by 2 heart attacks, in May 1983. No information on site of lesion is available. A right hemiplegia which necessitates the use of the non-preferred hand for writing suggest a left-hemisphere lesion.

IC received 9 years schooling and had worked as a shop assistant when in paid employment. She had read newspapers, magazines and the occasional romantic novel before her CVA but is unable to read as a pastime since it occurred. She is physically frail and unable to manage everyday chores on her own (she now lives with her daughter) but seems mentally alert and well-orientated. She was willing to undergo testing but obviously found testing sessions very tiring and her daughter was anxious that sessions should not be too long or frequent - hence the incomplete data.

4.12.2.2 Aphasia and Dysgraphia

IC's profile on the Whurr Aphasia Screening Test (see Appendix I) indicates a moderately severe Broca's aphasia. An oral dyspraxia leads to articulatory difficulty which becomes severe as a result of fatigue or stress. The BDAE was not administered in this case because of its length. IC obtained full scores on the majority of the Whurr subtests of receptive function (auditory and reading comprehension). She was slightly impaired in her ability to execute simple written commands (4/5) and unable to execute complex written commands (0/5). Simple commands in oral form were executed without error; the ability to execute complex oral commands was slightly reduced (4/5). Scores on subtests of expressive function show more evidence of impairment. IC was able to repeat 3/5 plosive sounds, 3/5 words and 2/5 sentences but was unable to repeat any groups of sounds or to reproduce verbally the alphabet, although saying the days of the week in sequence and counting from 1 to 20 caused no problems. IC was impaired on all subtests requiring naming and oral description. She was unimpaired in her ability to copy letters, words and sentences, and to write numbers and letters to dictation. Writing words to dictation was slightly impaired (4/5); writing sentences to dication (1/5) and written confrontation naming (3/5) were more severely impaired. IC was unable to perform the subtests requiring written description.

4.12.2.3 **Neuropsychological Baseline Test**

The only additional neuropsychological test administered was the PPVT (spoken version). On this test IC obtained an IQ equivalent of 78.

4.12.2.4 **Reading and Repetition Tests**

The results of reading and repetition tests are shown in Tables 4.12.1 to 4.12.8. A transcription of IC's reading of the passage of text (first 11 sentences only) is provided in Appendix II. Error types are shown in Tables 4.12.9 to 4.12.11. Figures 4.12.1 to 4.12.4 show graphically the proportions of different types of reading responses to words and nonwords (major error categories only). The error of articulation appears as a major category in IC's error corpus since such errors account for a large proportion of total errors.

Table 4.12.1 READING AT THE SINGLE LETTER LEVEL

Test		Number Correct	Percentage Correct
Single letter naming	n = 26	15	58
Single letter sounding	n = 24	1	4

Table 4.12.2 READING AT THE SINGLE WORD LEVEL

Test		Number Correct	Percentage Correct	Significant effect of Variable
Imageability (standard)				
High Imageable	n = 20	9	45	+
Low Imageable	n = 20	3	15	
Part of speech (easy)				
Noun	n = 20	10	50	-
Verb	n = 20	8	40	
Adjective	n = 20	7	35	
Function word	n = 20	11	55	
Part of speech (revised)				
Noun	n = 25	13	52	+
Verb	n = 23	7	30	
Adjective	n = 25	11	44	
Function word	n = 37	25	68	
Regularity of spelling (standard)				
Regular	n = 10	5	50	-
Irregular	n = 10	6	60	
Frequency				
High Frequency	n = 23	14	61	+
Low Frequency	n = 23	7	30	

Table 4.12.3 COMPREHENSION TEST

Test		Number correct	Percentage correct
Semantic Probe	n = 16	15	94

Table 4.12.4 TESTS OF NONWORD PROCESSING

Test	Number correct	Percentage correct	Significant effect of Variable
Pseudohomophony I			
Pseudohomophones n = 15	8	53	+
Non-pseudohomophones n = 15	0	0	

Table 4.12.5 SILENT TESTS OF PHONOLOGY

Test	Number correct	Percentage correct
Silent test of phonology I		
Nonword n = 50	42	84

Table 4.12.6 TESTS OF REPETITION ABILITY

Test	Number correct	Percentage Correct
Pseudohomophony I		
Words n = 15	11	73
Nonwords n = 15	6	40
Imageability (standard)		
High imageable n = 20	13	65
Low imageable n = 20	12	60

Table 4.12.7 Reading and Repetition Responses to Nonwords

PSEUDOHOMOPHONES

Stimulus	Reading	Repetition
wun/wʌn/	+	+
uze/juz/	-	+
woz/wɒz/	what	+
owt/aʊt/	wood	+
wor/wɔ/	+	/dʒ/
bie/baɩ/	+	
hoo/hu/	loo	+
fue/fju/	+	+
oan/oʊn/	an	/doʊn/
akt/ækt/	ark	and
doo/du/	+	+
nue/nju/	do	/bə..du/
kan/kæn/	+	+
sed/sɛd/	+	+
ize/aɩz/	+	+
Total correct	8	11

NON-PSEUDOHOMOPHONES

Stimulus	Reading	Repetition
bon/bɒn/	ban	/bɒŋ/
mun/mʌn/	/mɒn/	/mʌm/
gue/gju/	glue	+
oin/ɔɩn/	/an/	/ədən/
foo/fu/	for	+
kie/kaɩ/	sigh	/skaɩ/
hoz/hɒz/	/ɛs/	+
ekt/ɛkt/	/a-də-tu/	/dənd/
bue/bju/	blood/blue	/bru/
kag/kæg/	/æg-kɒd/	/kə/
sem/sɛm/	same	+
ont/ɒnt/	art	/ɒn/
noo/nu/	/nə..nə/	+
ine/aɩn/	in/on	+
ume/jum/	arm	/mə/
Total correct	0	6

Table 4.12.8 Reading and Repetition of high and low imageable words

HIGH IMAGEABLE		
Stimulus	Reading	Repetition
hand	+	+
office	/ɒdɩs/	+
street	piece	+
book	+	+
person	+	+
letter	+	+
student	+	/dudənt/
blood	+	+
hospital	metal	+
skin	/hənə/	+
journal	/'dɜdəl/	/dɜnəl/
oxygen	/'ɒndɩdən/	/'dzɩndən/
gift	/bəd/	/gɩdə/
angle	/'ændəl/	/'ændəl/
cigar	/səˈnɑ/	/səˈdə/
moss	+	+
apple	+	+
engine	+	+
musician	-	/mə..nə/
landscape	/'læd ˌdeip/	+
Total correct	9	13

LOW IMAGEABLE		
Stimulus	Reading	Repetition
fact	+	+
moment	/nə.. mə/	+
reason	-	+
idea	+	+
amount	mount	/maɷnt/
method	/nɛd/	/ə'tɒd/
average	/'ædədɩdz/	/'ædədɩdz/
truth	/tɷθ/	+
attitude	/'ædədud/	+
soul	/noɷ/	/soɷld/
promise	/pəd..pəv/	+
origin	on	/ɒn/
fate	/fɛd/	+
folly	+	+
topic	/'tɒdək/	+
hint	mint	+
event	/'ɛdə/	/'ɩdənt/
excuse	excuse me	+
reminder	/əˈmɑɩndə/	/də/
democracy	-	/də..də/
Total correct	3	12

Table 4.12.9 READING ERRORS - WORDS

	Number of errors	Percentage of errors
Visual	28	18
Visual or Semantic	1	1
Derivational	1	1
Inflectional	2	1
Function Word Substitutions	5	3
Semantic	3	2
Errors of articulation	70	45
Other	47	30
Incomplete response 29		
Completion 3		
Literation 1		
Perseveration 1		
Unclassified 13		
TOTAL ERRORS	157	
Words misread	148	50
Omissions	12	4
Words read correctly	136	46
TOTAL PRESENTED	296	
Error responses corrected		2
Additional errors due to multiple responses		7

Table 4.12.10 READING ERRORS NONWORDS

		Number of errors	Percentage of errors
Lexicalisations		16	67
Visually similar to stimulus		10	
Visually distinct from stimulus		6	
Incorrect nonwords		3	13
Other		5	21
Perseveration	1		
Incomplete	2		
Unclassified	2		
TOTAL ERRORS		24	
Nonwords misread		21	70
Omissions		1	3
Nonwords read correctly		8	27
TOTAL PRESENTED		30	
Additional errors due to multiple attempts			3

Table 4.12.11 TEXT READING ERRORS

	Number of errors	Percentage of errors
Errors on stem of content words	18	53
Derivational/inflectional errors	3	9
Errors on function words n = 39	9	23
Total words in passage	73	

Fig. 4.12.1 Reading responses to words : IC

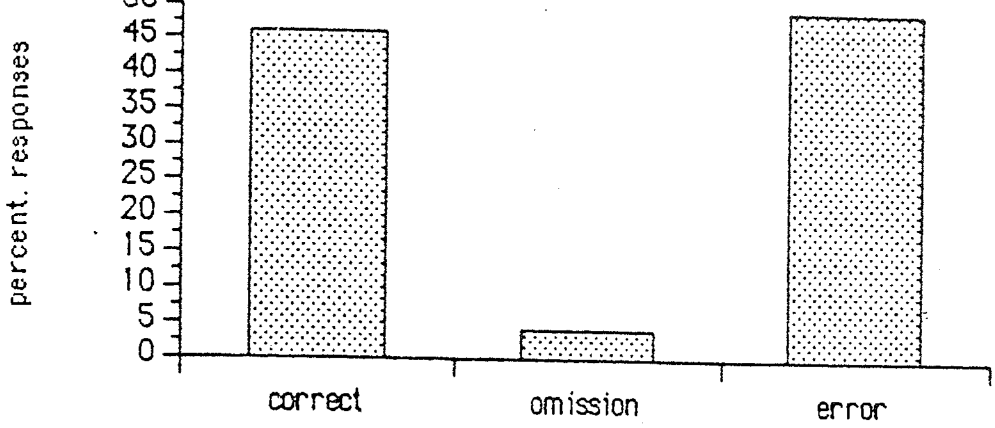


Fig. 4.12.2 Reading responses to nonwords : IC

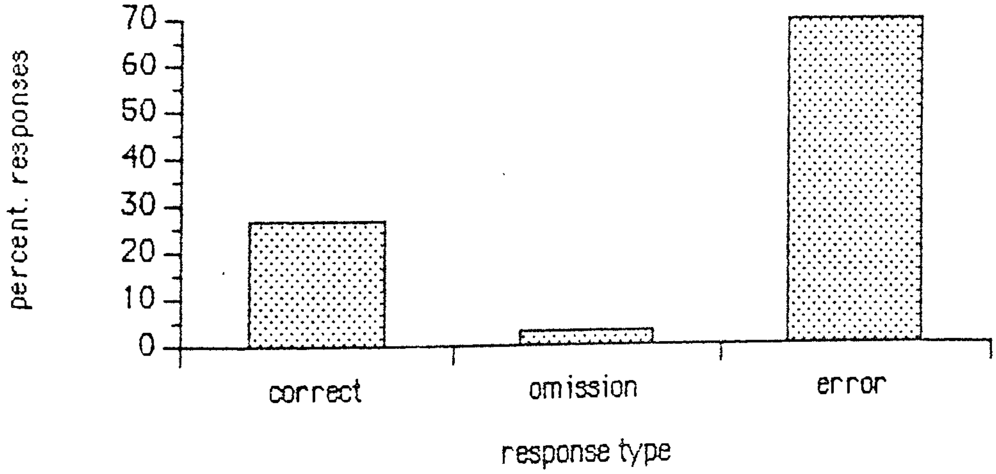


Fig.4.12.3 Types of error response to words : IC

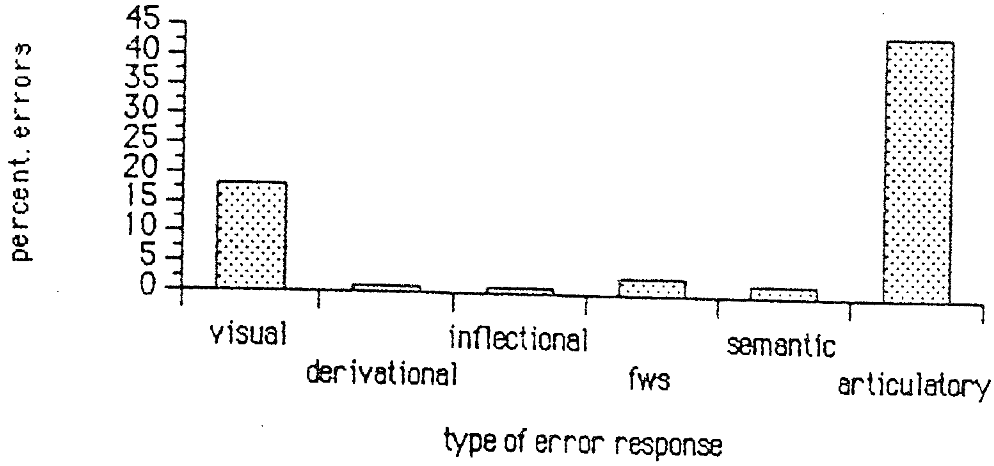
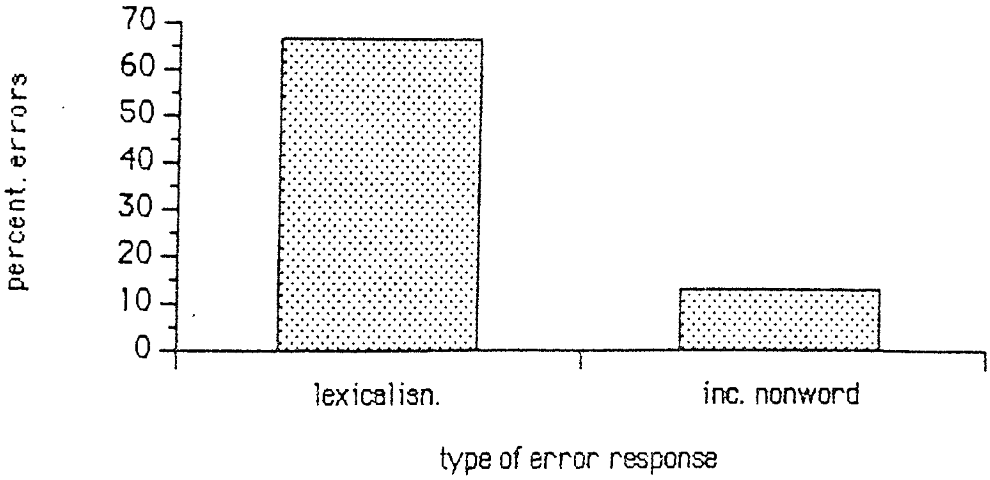


Fig.4.12.4 Types of error response to nonwords : IC



4.12.2.5 **Analysis of Test Results**

4.12.1.5.1 **Reading at the Single Word Level**

IC's score on reading high-imageable words was significantly higher than her score on reading low-imageable words (X^2 (1df) = 4.3, $P < .05$). This significant difference remains when errors of articulation are counted as correct, the high-imageable score becoming 15/20 and low-imageable score 7/20 (X^2 (1df) = 6.4, $P < .05$). High frequency words are read significantly better than low frequency words (X^2 (1df) = 4.3, $P < .05$) and there is a significant effect of part of speech in the revised test (X^2 (3df) = 8.5, $P < .05$) in which function words are read better than other parts of speech. A similar pattern is observed in the easy Part of Speech Test but, in this test, the difference does not reach significance (X^2 (3df) = 3, $P > .05$). There is no significant effect of regularity of spelling ($Z = 0$, $P > .05$). Performance on the Semantic Probe Test is significantly above chance (chance = 8 ± 4). There is a highly significant effect of pseudohomophony on nonword reading on the Pseudohomophony I Test (X^2 (1df) = 11.5, $P < .001$). On the Silent Test of Phonology, Nonword Version, the Hit Rate was .9, the False Alarm Rate .1 yielding a d' of 2.56.

4.12.2.5.2 **Tests of Repetition Ability**

Words were repeated better than nonwords in the Pseudohomophony I Test, but this difference did not reach significance (X^2 (1df) = 3.4,

P .05). There was no significant difference in the repetition of High-imageable and Low-imageable words (X^2 (1df) = .1, $P > .05$).

4.12.2.5.3 Reading Errors: Words

The highest proportion (45%) of reading errors are errors of articulation. There are significantly more errors in this category than in the other large error category, visual errors, which account for 18% of total errors (X^2 (1df) = 18, $P < .001$).

4.12.2.5.4 Reading Errors: Nonwords

The highest proportion of errors (67%) are lexicalisations. There are significantly more lexicalisation than incorrect nonword errors (X^2 (1df) = 8.9, $P < .01$). The difference between the number of lexicalisations which are visually similar to the stimulus and the numbers which are visually distinct is not significant (X^2 (1df) = 1, $P > .05$).

4.12.2.5.5 Reading Errors: Text

In reading text, IC makes significantly fewer errors on function words than on the stems of content words (X^2 (1df) = 6.9, $P < .01$).

4.12.2.6 Discussion of Reading Impairment

4.12.2.6.1 The Lexical-Semantic and Direct Routes

There is no reason to suppose that either the lexical-semantic or the phonological route is severely impaired. When the results of tests at the single word level are considered, firm evidence for or against the normal operation of the direct route is not available but reliance on the lexical-semantic rather than the direct route is suggested by the presence of an imageability effect. The majority (45%) of reading errors on words are due to articulatory difficulty. The majority of visual errors (which account for 18% of the total errors) may also be the result of articulatory problems - where an error response is a word the two types of error responses are hard to separate. Visual errors have been classified as such, largely on the basis of the speed and lack of articulatory effort with which the response was produced. There is in fact, only one unequivocally visual error in the corpus (<u>beggar</u> -> "beginners"). The 3 derivational and inflectional errors and 3 of the function word substitutions are less easy to explain away as being articulatory in nature as is the semantic error <u>bright</u> -> "pert" although the latter could reveal the use of a deliberate strategy of substitution when the correct response cannot be articulated as in the semantic error response <u>machine</u> -> /meɩ/, /meɩʃ/, tool.

If visual, derivational, inflectional and semantic errors are indeed produced by this patient for whom there is evidence that the phonological route is intact then their occurrence suggests that the lexical-semantic route is faster in operation than the phonological route - there is no way in which the phonological route could output a semantic error response, and the apparently visual errors could only occur as a result of serious mistranslations in the course of grapheme-phoneme conversion or possibly from severe impairment in the abstract letter recognition system (e.g. hint -> "mint" would require either that the grapheme h be translated as the phoneme /m/ or that the letter h be recognised as the letter m - a possible confusion in this case but less likely in the case of enjoy -> "annoy" which would involve the recognition of j as n). However, since the number of errors which can unequivocally be assigned to the categories under discussion is small, it would be inappropriate to attach too much weight to their occurrence in the error corpus of this patient.

4.12.2.6.2 The intact phonological route

IC read 53% of pseudohomophonic nonwords and no non-pseudohomophonic nonwords. The success rate of 53% is comparable to IC's success rate on other word reading tests (e.g. 50% nouns on the easy Part of Speech Test were read correctly as were 45% of high-imageable words). The mechanism which produces the pseudohomophone effect in phonological dyslexic patients is, as noted in Chapter 2, unclear. The effect has been shown, on certain occasions (Martin, 1982; Nolan and Caramazza, 1982) to depend on the visual similarity of the nonword to a homophonic word; the findings of Derouesne and Beauvois (1985) suggest the possibility of approximate phonological access to the oral word representation system. That IC's ability to read aloud pseudohomophones as well as she is able to read real words is not due to the involvement of the lexical route in connection with either of these two possible strategies is suggested by her performance on the nonword version of the silent test of phonology. The nonword stimuli in this test are not pseudohomophones yet IC was able to judge correctly whether or not nonword pairs were pseudomophonous in 85% of cases - a success rate which exceeds that obtained on any oral reading test. The errors which did occur could conceivably result from letter misidentifications; in this connection it may be noted that IC was able to name correctly only 15/26 visually presented single letters.

In claiming that the phonological route is unimpaired, however, it is necessary to note that there is no significant difference between repetition of words and nonwords in the Pseudohomophony I Test. If articulatory difficulty is the only cause of impaired nonword reading, a significant effect should be found here. In fact, X^2 closely approaches significance in this case but it is possible that the explanation of poor nonword reading is slightly more complex than I have allowed.

Since it is argued that IC is able to make grapheme-phoneme conversions, it is interesting to note that, like Funnell's (1983) patient FL, she is impaired in her ability to give letter sounds in response to visually presented letters, giving the correct response to only 1 item.

4.12.2.6.3 The imageability effect

IC's reading shows a significant effect of imageability, high-imageable words being read more efficiently than low-imageable. This effect is not unusual in cases of phonological and deep dyslexia and is assumed to result from a selective impairment within the semantic system. Why should such an effect occur in a patient who is able to use the phonological route? If there is an impairment in this patient's semantic system and the lexical-semantic route is indeed a faster-operating route than the phonological route, longer latencies for low-imageable words might be expected but there is no reason why more errors should occur on low-imageable words. Is the effect merely one of articulation? Although high- and low-imageable words in the test are matched for frequency of occurrence, it is conceivable that IC herself was not in the habit of articulating low-imageable words so frequently as high-imageable ones. This explanation is unlikely for two reasons. Firstly (assuming that the classification of errors is accurate) all those errors classified as errors of articulation were counted as correct to give new total scores for the test. If IC's problem is in articulating low-imageable words, the imageability effect should have disappeared after this manipulation of the results. In fact, a significant effect of imageability remained with the X^2 value increasing rather than decreasing. Low-imageable words seem to elicit more visual errors than do high-imageable words. Secondly, and more convincingly, if the effect is due to articulatory difficulty, it should remain when test items are administered in a repetition task. In fact, the effect disappeared completely when high- and low-imageable words were presented for repetition.

Another possibility is that the likelihood of production of a correct response is increased if output from more than one system can be utilised in the production of the response. No attempt will be made to clarify the "summation of activation"[2] process since such an explanation is to be immediately rejected. This explanation would predict that all words which are unsuited to processing by the lexical-semantic route (including low-imageable words where low-imageable semantic representations are impaired) and of course all nonwords which do not have a semantic entry should be read less well than high-imageable words. In fact, both meaningless but pseudohomophonic nonwords and function words which are low in imageability are read better than low imageable abstract words. A further possibility is that the lexical-semantic route is in some way the "preferred" route for word reading. This vague possibility is similarly easily rejected on the grounds that function words should then be read by this route and that as they are low in imageability they should be read less accurately. The significant function word advantage which also occurs in the reading aloud of text, is probably explicable in terms of frequency. IC does show a facilitatory effect of frequency in the test of this variable. Although the words in the Part of Speech Tests are matched for frequency they have been matched according to the Thorndike-Lorge (1944) norms in which the High Frequency, AA, band in fact covers a range of frequencies. Ellis et al (1983) have noted that in a more precise frequency count, function words tend to be more frequent than content words.

Questions relating to the imageability effect observed in this patient cannot be resolved on the basis of the data available. The results, as they stand, seem to suggest that function words are treated differently from content words in the reading aloud process as tentatively suggested by Patterson (1982) although there is much conflicting evidence in respect of such an account. The data does provide further evidence that the word class effect is not simply a manifestation of the imageability effect as suggested by Allport and Funnell (1981). In this connection, further testing in which the effect of word length was investigated and, if necessary controlled, would have been helpful. The low-imageable words used were longer than the pseudohomophonic nonwords and length could be a factor which reduces the efficiency of the phonological route. However many 4-, 5- and 6- letter function words were read correctly.

4.12.2.7 **Summary and Conclusions**

IC's reading problems are, to a certain extent, the result of an articulatory disorder. However, the effect of imageability on performance indicates that there is an additional central disorder in which the semantic representations for low-imageable words are selectively impaired. Although there is evidence that IC is able to use the phonological route, this route does not operate in such a way as to prevent the occurrence of errors on low-imageable words. Possible explanations of this effect are discussed. It is concluded that although no satisfactory account of IC's reading impairment can be given on the basis of the data available, good performance on function words in conjunction with an imageability effect on content words does suggest that function and content words may be processed in different ways by the reading system.

Notes on Case Report X

1 IC's test results are not therefore included in the summary tables in Chapter 5.

2 This item was suggested by Phillips (personal communication)

Chapter 5

VARIETIES OF ACQUIRED PHONOLOGICAL DYSLEXIA

5.1 The locus of impairment within the phonological route

5.1.1 Introductory comments

The subsystems within the phonological route in the standard model are described in Chapter 1 (Section 1.3.1.2). They are:

i) the Resegmentation System
ii) the Phoneme Allocation System, and
iii) the Blender.

It is hypothesised that these different subsystems can be selectively impaired. Different patterns of nonword reading behaviour reflecting impairment at different loci within the phonological route thus represent different varieties of phonological dyslexia. Reciprocally, evidence of such selective impairment also serves to confirm the presence of separable cognitive components within the phonological route. Nonword stimuli which make differential demands on the different subsystems are listed in Chapter 3 (Section 3.1.5.2), they form the Structured Nonwords Test. The performance of each patient on this test is discussed in his/her Case Report. A summary table is provided in this chapter (Table 5.1).

Patient	Type of item A	B	C	D	E	F	G	H	Primary locus of impairment
DA	0	0	0	0	0	0	0	0	-
DP	20	10	20	20	10	0	0	20	-
TW	0	10	20	10	10	0	0	10	-
CB	60	45	30	80	30	55	45	35	Phoneme Allocation System
JS	65	50	35	80	35	45	50	45	Phoneme Allocation System
ZS	25	5	10	40	10	45	20	25	Phoneme Allocation System/ Blender
PG	45	75	50	80	65	45	40	50	-
FW	60	-	-	-	40	30	80	-	Reseg-mentation System
WPB	80	75	50	60	60	60	75	70	Reseg-mentation System

Scores are expressed as percentage correct

Table 5.1 Summary of results of the Structured Nonwords Test

5.1.2 Evidence for the different loci of impairment

DA (Case Report I) was unable to read any items in the test and DP and TW (Case Reports II and III) read so few items that results could not be subjected to statistical analysis. The scores obtained by PG (Case Report VII) do not implicate any one subsystem as the primary locus of impairment. When scores on items which require resegmentation but contain a grapheme for which there is only one possible phonemic realisation are as high as scores on items which do not require resegmentation, while scores on items which require resegmentation and contain an inconsistent grapheme are significantly lower, the Phoneme Allocation system is implicated as the primary locus of impairment. This pattern of scores occurs in three cases (CB, Case Report IV; JS, Case Report V; and ZS, Case Report VI).

In the case of ZS, performance is also poor on items which place added demands on the Blender (those containing a consonant cluster) and it is argued that this subsystem is also severely impaired in this case.

When scores on both types of items which require resegmentation are low, relative to scores on items which do not require resegmentation, the Resegmentation System is implicated as the primary locus of impairment. This pattern of scores occurs in two cases (FW, Case Report VIII and WPB, Case Report IX). In the case of FW, not all subtests were administered; however, the differential performance on items requiring resegmentation and non-resegmentable items is clear even from the limited data available. In no case is any one type of item read without error. Hence conclusions are concerned with the primary locus of impairment.

On the basis of the data presented here, it appears that, although the subsystem most severely impaired can be identified in many cases of phonological dyslexia, some additional, less severe, impairments within the route are usually present. The picture would be neater and the evidence for selective impairment of different subsystems stronger if this were not the case. However, the extent to which the load on the subsystems can be reduced varies. The Phoneme Allocation system and the Blender are always required for nonword reading; the load on the subsystems can be kept to a minimum but the subsystems cannot be bypassed. The operation of the Resegmentation System, however, is not required when stimuli in which there is a one-to-one correspondence of letter to sound are presented. It is relevant to note, in this connection, that the overall scores on non-resegmentable items in the cases where the Resegmentation System is the locus of impairment[1] are high (70% in the case of FW and 77% in the case of WPB).

The results of this test distinguish two varieties of phonological dyslexia, one in which the major impairment is in the Resegmentation system and one in which the major impairment is in the Phoneme Allocation System. The data presented does not provide evidence for a type of dyslexia in which the major impairment is of the Blender although this subsystem and the Phoneme Allocation System are impaired in the case of ZS (Case Report VI). It is predicted that impairment of this subsystem alone will be observed if further data is gathered from phonological dyslexics.

The data presented support the claim that the Resegmentation and Phoneme Allocation Systems are functional subsystems within the phonological route.

5.1.3 Additional evidence for the different loci of impairment

The difficulty of testing the operation of subsystems within the phonological route using tasks which do not involve the reading aloud of nonwords is noted in Chapter Three. The tests relevant to the operation of the different subsystems are as follows:

Resegmentation System:	i)	Segmentable words
	ii)	Hidden words
	iii)	Nonwords synthesised from words
Phoneme Allocation System:	i)	Sounding single letters
	ii)	Nonwords with inconsistent letters
Blender:	i)	Sound blending tests (I and II)
	ii)	Nonwords synthesised from words

A summary of the scores obtained on these tests is provided in Table 5.2. The table also shows whether or not there is a significant effect of the presence of an inconsistent letter and whether or not

Patient	Primary locus of impairment	Visual Segmentable Words	Hidden Words	Sounding Single Letters	Sound Blending I (words only)	Sound Blending II (nonwords)	Nonwords synthesised from words (without colour cue)	Nonwords synthesised from words (with colour cue)	Nonwords with inconsistent letter	Nonwords without inconsistent letter	Effect of presence of inconsistent letter	Effect of pseudohomophony
DA	–	93	90	13	38	38	0	0	na	na	na	na
DP	–	90	10	17	71	51	40	10	3	8	–	–
TW	–	93	60	0	42	11	40	10	3	0	–	–
CB	Phoneme Allocation	93	95	79	79	20	40	20	28	53	+	–
JS	Phoneme Allocation	80	30	4	46	29	20	50	14	28	–	–
ZS	Phoneme Allocation /Blender	90	0	4	42	14	10	10	0	0	–	–
PG	–	100	75	92	58	11	70	60	39	42	–	–
FW	Reseg-mentation	na	na	17	na	na	na	na	na	na	na	na
WPB	Reseg-mentation	97	95	0	13	43	70	20	61	61	–	–
IC	–	na	na	4	na	na	na	na	na	na	na	+

scores are expressed as percentage correct

Table 5.2 Summary of results of tests relevant to loci of impairment there is an effect of pseudohomophony.

The probability of additional task demands and/or involvement of an alternative processing route noted in dicussion on the tests, is borne out by the results.

5.1.3.1 **The Blender**

CB, JS, PG and WPB completed the Structured Nonwords Test and do not show evidence of impairment to the Blender. Their results on the Sound Blending I Test (words only) vary from 13% (WPB) to 79% (CB). Results on the Sound Blending II Test (nonwords) vary from 11% (PG) to 43% (WPB). CB and PG are significantly more impaired when items to be blended are nonwords; JS and WPB are not.

There is no correlation between scores on the auditory sound blending tests and scores on subtests B and G for these four patients and ZS (Blending subtests and Sound Blending (Words): Kendall's $S = -2$, P .05; Blending subtests and Sound Blending (Nonwords): Kendall's $S = 4$, P .05). Clearly the two types of task require the operation of different processors and the auditory sound blending tasks are of little value in ascertaining the extent to which the Blender in the phonological route is impaired. In this case, ZS's low scores on the auditory sound blending tasks and on the Blending subtests are not due to a single impairment and do not provide additional evidence to support the claim that the Blender is impaired.

The ability to blend words (in the Nonwords Synthesised from Words

Test) may also dissociate from the ability to blend phonemes. Some evidence for such a dissociation is provided by the lack of correlation between scores on the Blending subtests and the scores in the colour-cued version of the Nonwords Synthesised from Words Test (Kendall's $S = 7$, $P > .05$) although the value of S closely approaches significance in this case.

5.1.3.2 The Resegmentation System

Performance on the Visual Segmentable Words Test is relatively good in all cases where the test was administered. WPB is the only patient who completed this test in whom the Resegmentation System is impaired. His performance on this test and on the Hidden Words Test is extremely good (97% and 95% correct respectively) in spite of his difficulty in reading aloud nonwords which require resegmentation. Again, there is no correlation (based on the scores of JB, JS, ZS, PG and WPB) between scores on items in the Structured Nonwords Test which require resegmentation but do not contain inconsistent graphemes (Types D and F) and scores on the Visual Segmentable (Kendall's $S = 1$, $P > .05$) and Hidden Words (Kendall's $S = 4$, $P > .05$) Tests. The dissociation predicted in the test descriptions (Chapter III, Section 1.5.6) is therefore evident in the empirical data.

In cases where there is a significant improvement in performance when a colour cue is provided in the Nonwords Synthesised from Words Test, an impairment in the ability to segment the letter string may be indicated. The colour cue facilitates the segmentation operation. A significant effect of the presence of a colour cue is only observed in the case of WPB. However, in view of his good performance on the Segmentable and Hidden Words Tests, the pattern of scores may be interpreted as reflecting WPB's choice of strategy (i.e. he did not search for component words) rather than an inability to segment in this way. Thus, this pattern of results is subject to alternative explanation and does not provide additional evidence for impairment of the Resegmentation System.

The additional tests of segmentation and blending ability were based on the tests administered by Funnell (1983) and were in fact developed by Funnell to investigate the ability to segment lexical items and thus to address the issue of whether nonwords are read by non-lexical or lexical procedures. The data presented here tend to support Funnell's conclusion that the phonology of nonwords is not derived from lexical analogy procedures and will be discussed in relation to this issue in Section 5.1.5.

5.1.3.3 **The Phoneme Allocation System**

The dissociation between the ability to sound single letters and to read nonwords, first reported by Funnell (1983) has been discussed in Chapter One (Section 1.3.1.2.1.4). Funnell's patient FL was unable to sound any visually-presented letters but read 74% of nonwords. Similarly, WPB was unable to sound any visually-presented letters but was able to read 58% of the nonwords with which he was presented. Conversely CB was able to sound 79% of visually-presented letters but was able to read only 42% of the nonwords with which she was presented. CB's results indicate an impairment in the Phoneme

Allocation system in spite of her ability to sound letters. The data provide further support for the hypothesis that there is a store of syllabic letter sounds independent of the Phoneme Allocation System.

The test composed of nonwords with or without inconsistent letters involves the reading aloud of nonwords and is the only additional test in which pattern of performance should not differ from the pattern of performance in the Structured Nonwords Test. In the three cases in which the Phoneme Allocation System is implicated as the primary locus of impairment (CB, JS and ZS), a significant effect of the presence of an inconsistent letter should occur. The expected pattern of results is observed in the case of CB. JS read nonwords without an inconsistent letter better than she read nonwords with an inconsistent letter. However, this difference in scores does not reach significance. ZS was unable to read any items in the Inconsistent Letters Test. This failure is not easy to explain since his overall nonword reading score is 16%. The zero scores do not argue against the hypothesised locus of impairment as a reverse effect would do but provide no supportive evidence. The results do provide supportive evidence in the case of CB and JS, although in the latter case, the evidence would be more convincing if the difference in scores reached significance. It is relevant to note that in cases where responses to items in the Structured Nonwords Test do not suggest severe impairment of the Phoneme Allocation System there is no significant difference between scores on items with and items without an inconsistent letter. In the case of WPB, scores on both types of item are identical (61% on each). In the case of PG, the score on items without an inconsistent letter (42%) is very slightly higher than the score on items with an inconsistent letter (39%).

5.1.4 Error types

The possibility of errors failing to reflect the hypothesised impairment within the phonological route is discussed in Chapter Three (Section 3.1.5.2). It is assumed that nonword stimuli which increase the load on one subsystem while the load on other subsystems is held constant will be read less efficiently if that particular subsystem is malfunctioning or non-functional. It was noted that errors of an appropriate type would provide additional evidence for the hypothesised locus of impairment. The type of error which impairment of a particular subsystem would predict is not always clear however. Failure of the phonological route to produce any output might lead to an omission or a lexicalisation error so that either of these error types is compatible with failure of any given subsystem. When error responses are incorrect nonwords, the occurrence of an error on the grapheme or cluster of graphemes which place an added load on the impaired processor might be expected. An error of resegmentation might involve realisation of a digraph as two phonemes or omission of one letter in the digraph. Impairment of the Phoneme Allocation System could lead to misconversion of any grapheme, but it is possible that misconversion of an inconsistent grapheme would be most likely. Failure of the Blender could lead to an ublended sequence of phonemes being output or simplification of consonant clusters.

The errors made by each patient are discussed in the Case Reports and this discussion will not be repeated here. In each case, a number of errors of the predicted type are observed but this number often forms a small proportion of the total errors on the test. Lexicalisation errors account for the highest proportion of error responses on the subtests on which a low score is interpreted as reflecting impairment of a given subsystem in each case. It is concluded that error analysis, while not providing evidence against the hypothesised locus of impairment in any case, does not provide corroborative evidence for the impairment of a given subsystem.

5.1.5 A note on the processing of the silent e

The possibility of a distinct parsing operation being carried out in cases where a final silent e influences the phonemic realisation of a vowel is discussed in Chapter 1 (Section 1.3.1.2.2.2).It is noted that the conversion operation cannot be carried out by means of simple left to right parse and that the marking function of the e must be available at the stage of Phoneme Allocation. Thus a final e may not be processed in the same way as digraphs by the Resegmentation System. The mechanism by which the final e is processed is not investigated in this work. The scores on Type H items in the Structured Nonwords Test (Type H items are of the structure VCe) do not correlate with the scores on Type D items (Kendall's $S = 1$, $P > .05$). Type D items are of the same letter and phonemic length as Type H items and both types of item require resegmentation. The absence of a significant correlation strongly supports the hypothesis that a resegmentation process which differs from the simple left-to-right parse is required when a lexical item contains a silent e. There is however a positive correlation between the scores on Type C items and

Type H items (Kendall's $S = 9$, $P < .05$) although scores on Type H items are consistently higher than scores on Type C items. (Only scores of patients who completed the full structured Nonword Test are included in this analysis). This suggests that, as proposed in Chapter 1 (Section 1.3.1.2.2.2), the final e is processed by the Phoneme Allocation System rather than the Resegmentation System.

5.1.6 The Pseudohomophone Effect

Alternative accounts of the facilitatory affect of pseudohomophony are discussed in Chapter 2 (Section 2.2). The effect has been observed in a number of cases of phonological dyslexia and may reflect use of a strategy of approximate visual access or difficulty in articulating unfamiliar strings of phonemes. The data presented does not address questions relating to the source of the effect since only one patient discussed in the present work is sensitive to pseudohomophony in nonwords. This is IC (Case Report X). In this case the effect results from articulatory difficulty; performance on a silent test of phonology indicate that IC is able to assemble phonology. According to the definition of phonological dyslexia discussed in Chapter 2 (Section 2.1) in which the defining characteristic is an impairment of nonword relative to word reading, the case should be classified as one of phonological dyslexia. When nonword stimuli are non-pseudohomophones, there is a significant difference between word and nonword reading scores. However, the retrieval and assembly of articulatory programs is effected subsequent to the point at which a phonological representation enters the Response Buffer. After this point, the independent lexical and non-lexical routes merge. Problems with articulation are not associated with deficits within the phonological route itself. Thus although performance on certain tests suggests phonological dyslexia, there is no theoretical justification for such a classification and IC is not presented as a case of phonological dyslexia.

5.1.7 Lesions of pathways in the phonological route

It is argued in the Introduction to Case Reports I-III (Section 4.1) that a total (or almost total) lack of output from the phonological route is the result of a lesion of one of the pathways between subsystems or of absolute loss of use rather than of the malfunctioning of a subsystem. In the three cases (DA, DP andTW, Case Reports I - III) in which this lack of output is observed, it has not been possible to specify the precise locus of the lesion. Such precision is, perhaps, unnecessary since the effect of the lesion on nonword reading (i.e. the loss of output from the phonological route)is the same regardless of the point at which it occurs.

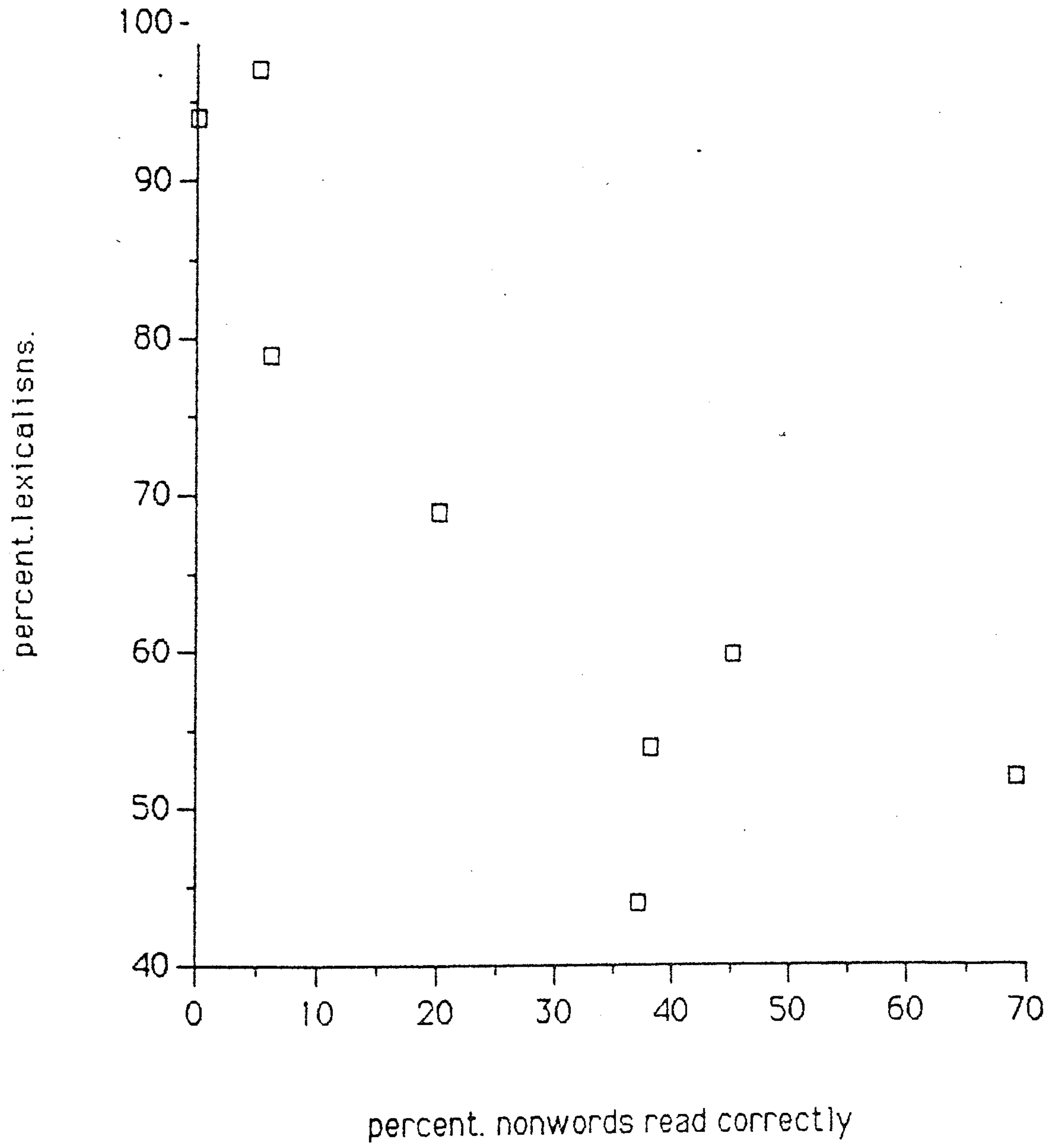
The occurrence of a phonological dyslexia in which there is no output from the phonological route because of a lesioned pathway or a subsystem becoming totally non-functional is theoretically predictable and it is justifiable to include it as a sub-type of phonological dyslexia within a classification system based on the standard model.

It is relevant to note here that there is a negative correlation between the degree of impairment of the phonological route as measured by the proportion of nonwords read correctly[5] and the proportion of error responses [6] which are lexicalisations (Kendall's $S = -19$, $P < .05$). Figure 5.1 shows this relationship graphically; numerical data appears in Table 5.7. The more severe the impairment to the phonological route, the more likely it is that the route will produce no output at all and that the lexical route will make available a phonological representation of a lexical item in response to a nonword stimulus.

5.1.8 **Summary and conclusions regarding different loci of impairment**

The hypothesis to be tested (see Chapter 2, Section 2.1.11) for initial discussion) predicted that different types of difficulty in assembling phonology would be observed. These differences would reflect the selective impairment of different subsystems within the phonological route. The set of stimuli designed to test the hypothesis contains items which increase the load on one subsystem while the load on the other subsystems is held constant. The results of this test provide evidence for the selective impairment of the Resegmentation System and Phoneme Allocation System. Furthermore, the effect of graphemic inconsistency on reading performance suggests that the account of the nature of the Phoneme Allocation System given in Chapter 1, Section 1.3.1.2.2.3 is an appropriate one. Results do not provide evidence for impairment of the Blender alone although, in one case, it appears that both the Blender and the Phoneme Allocation System are malfunctional. Thus empirical evidence for the occurrence of two of the predicted three sub-types of phonological dyslexia is provided. It is assumed that any given sub-system may be impaired in

Fig.5.1 Nonword reading ability and percentage of lexicalisation errors



conjunction with any other subsystem. Thus the case in which two subsystems are impaired represents a further predictable type of phonological dyslexia. A further sub-type of phonological dyslexia which the standard model predicts is that resulting from a lesioned pathway or total loss of a subsystem within the phonological route. Three cases of this type, in which there is a total or almost total lack of output from the phonological route, are reported. It is argued that an impairment of nonword reading resulting from difficulty in articulating non-lexical phonological representations is not a subtype of phonological dyslexia since the major impairment is not located within the phonological route.

5.2 Nonword reading test results and lexical analogy theory

5.2.1 Introductory comments

There is evidence to suggest that the use of lexical analogy is a possible strategy for nonword reading (see discussion in Chapter 1, Section 1.3.2.3). Proponents of lexical analogy theory suggest, however, that this is the only strategy by which nonwords are read and propose a model of the reading process in which there is no independent phonological route. It is concluded in this earlier discussion that the weight of evidence is in favour of the existence of an independent phonological route. The data presented in this work provides further evidence for the existence of this route. Relevant tests and aspects of reading behaviour are discussed in the following sections.

5.2.2 The effect of nonword structure

Significant differences between reading scores on different types of nonwords have been recorded in the structured nonwords test. The items in this test place differential loads on the hypothesised subsystems within the independent phonological roue. Analogy theory does not predict that varying structure in this way should affect performance. It does predict differences between items containing a consistent and items containing an inconsistent segment, since normal readers find the latter more difficult to process according to (Glushko, 1979) and/or (according to the nature of the nonword reading impairment) between items of different lengths. If stimuli are segmented into a "head" (initial letter) and "body" (final syllable) it is likely that in some cases items like <u>eap</u> which comprise a "body" only would be read more efficiently than items in which an initial letter must be synthesised with the final segment (e.g. <u>tood</u>). In fact no significant effect of length of item is reported in any case.

A significant difference between scores on items containing an inconsistent digraph and items containing a consistent digraph was observed in three cases. Items were examined on an ad hoc basis to ascertain whether the presence of an inconsistent grapheme implied the presence of an inconsistent segment and whether, likewise, consistency of a grapheme accompanied consistency of a segment. Segments do not always occur in the final position in short words and the number of occurrences of this type of segment was also recorded. Table 5.3 shows the number of Type C and E items and the number of Type D and F items which fall into each category[2].

	Type C and Type E items	Type D and Type F items
Consistent	23	28
Inconsistent	6	10
Do not form word - final segment	11	2
Total	40	40

Table 5.3 Reclassification of structured nonwords according to segmental consistency

Graphemic and segmental inconsistency do not co-vary. There are in fact more items containing an inconsistent segment within the set of items which do not contain an inconsistent digraph than in the set of items which contain an inconsistent digraph. Significant differences in performance are not therefore explicable in terms of segmental inconsistency.

5.2.3 The Consistent and Inconsistent Words Test

The possible effect of segmental consistency was further investigated by the inclusion of a test in which nonwords formed consistent and inconsistent word-final segments (see Chapter 3, Section 1.5.9 for description of test). The test was administered to 8 patients and results are summarised in Table 5.4.

There is no significant effect of segmental consistency in any case. The lack of an effect of this variable supports the conclusion that a lexical analogy strategy is not the only one available for processing nonwords. If it were then these patients, in whom the ability to read nonwords is severely impaired, should surely have been sensitive to a variable which affects normal readers.

Patient	No. of consistent items correct (n = 15)	No. of inconsistent items correct n = 15)
DA	0	0
DP	1	1
TW	2	3
CB	8	10
JS	3	5
ZS	1	2
PG	7	8
WPB	5	7

Table 5.4 Summary of scores on the consistent and inconsistent nonwords test

(statistical analysis of the results is provided in the individual case reports).

5.2.4 Phonemic realisation of the silent e: CB's responses

Responses to items of the form VCe in the Structured Nonwords Test are particularly relevant to the issue of analogy theory. All but two items in subtest H form word-final segments in real words when a single consonant or consonant cluster precedes the segment (e.g. tr/ibe; r/obe). This is not true of the items efe and epe. The final e is never pronounced in English words and use of analogy strategy should never result in errors of the type "ave -> / ævi /". Examples of this type of error occur in the responses of JS, ZS, PG and WB but there are only one or two such examples in each corpus[3]. In the case of CB this type of error accounts for 9/13 (69%) errors on subtest H[4]. The response "afe" -> / æfi / could have been produced by analogy with the anglicised French loanword "cafe". There is no way in which the use of analogy theory could have produced responses like "obe -> /oʊbi/" and "ave -> / ævi /. Such responses reveal impairment within the phonological route since the final e has clearly not been recognised as a marker. Nevertheless responses of this type are compatible with the application of grapheme-phoneme correspondence rules. They provide evidence for the existence of an independent phonological route and indicate that this patient is not producing error responses which are incorrect nonwords by means of lexical analogy.

5.2.5 The relationship between nonword stimulus and lexicalisation response

It is argued that the production of lexicalisation responses involves the activation of visually similar words in the visual word representation system (see Chapter 4, Section 4.1). According to lexical analogy theorists (e.g. Glushko, 1979) it is the final segment which is the unit of matching. Conflicting evidence which suggests that the initial letter or segment determines the choice of visually similar word is discussed in Chapter 1 (Section 1.3.2.3).

Further evidence for the salience of the initial letter or segment is provided by the visual error and lexicalisation responses of the phonological dyslexic patients discussed in this work. Table 5.5 shows the number of visual error responses to words sharing initial and final letters or segments for each patient. Table 5.6 shows the number of lexicalisation responses to nonwords sharing these segments. Responses in which the initial and final letters are common to stimulus and response and in which medial letters only are shared are omitted from the tables as it is not clear whether initial or final letters were salient in these cases.

Patient	Stimulus and Response share initial letter(s)	Stimulus and Response Share final letter(s)
DA	16	3
DP	41	25
TW	33	18
CB	37	0
JS	4	1
ZS	39	8
PG	22	3
FW	7	4
WPB	9	0
Total	208	62

Table 5.5. Visual error responses sharing initial or final letters

Patient	Stimulus and response share initial letter(s)	Stimulus and response share final letter(s)
DA	7	2
DP	55	51
TW	69	70
CB	51	14
JS	28	35
ZS	67	24
PG	35	24
FW	15	2
WPB	15	35
Total	342	257

Table 5.6 Lexicalisation responses sharing initial or final letters

The number of visual error responses sharing initial letters is greater than the number sharing final letters in every case. The difference between the total errors in the two categories is highly significant (X^2 (1df) = 78.9, P<.001). The number of lexicalisation responses sharing initial letters with the stimulus is greater than the number sharing final letters in some cases; in other cases the numbers in each category do not differ significantly. The responses made by WPB are exceptional in that significantly more responses share the final letter than share the initial letter. However, although WPB makes use of final letters in the production of lexicalisation responses he makes no visual errors which share final letters. When totals are compared, the number of responses sharing initial letters with the stimulus is significantly greater than the number sharing final letters (X^2 (1df) = 12,, P<.001). The pattern of responses is not compatible with the use of a segmentation process which separates initial letter and final segment and in which the final segment is the primary unit of matching in both word and nonword reading.

5.2.6 Reading by analogy tests

5.2.6.1 General comments

These tests require the patient to use a lexical analogy procedure for reading aloud nonwords although the strategy used may involve manipulation of a phonological representation rather than a process of orthographic segmentation and phonological synthesis. As noted in Chapter 3 (Section 3.1.5.10) the tests were not developed to investigate the use of orthographic segmentation but to investigate the extent to which a phonological representation can be manipulated. Implications of results for analogy theory are not always clear therefore. Items in the first (Deletion) test frequently require deletion of a medial letter and thus a type of segmentation procedure which differs from that described by analogy theorists. The second (Substitution) test contains items which require segmentation of the initial letter in the manner described by lexical analogy theorists.

5.2.6.2 The effect on performance of the provision of an analogous word

If a strategy of lexical analogy were being used for nonword reading, the effect on performance of the provision of an analogous word would vary according to the type of impairment present. If the primary impairment were in segmentation or blending, the provision of an analogous word would have little effect on performance. If, however, there were difficulty in obtaining a visually-similar word to form the analogy, the provision of the analogous word would improve performance. Unfortunately, a set of nonwords presented alone rather than as a word with a ringed letter matching the items to be read by analogy was not included in the test set. However, comparison was made between the mean nonword reading score on the Reading Easy Lexical Decision and Word-Matched Structured Nonwords Test[5] and the score on the second (substitution) Reading by Analogy Test. Table 5.7 shows the two scores for each patient.

There is a significant difference between scores in the cases of DA (Z

= 3.7, P<.01), DP (Z = 2.6, P<.05), TW (Z = 2.1, P<.05),CB (Z = 2.2, P< .05), and ZS (Z = 2.2, P<.=5). There is no significant difference

Patient	Percentage of lexicalisation errors	Mean nonword reading score	Score on the Reading by Analogy Test	Sig.diff. between scores
DA	94	0	25	+
DP	79	6	29	+
TW	97	5	21	+
CB	44	37	64	+
JS	54	38	55	-
ZS	69	20	0	+
FW	60	45	50	-
WPB	52	69	50	-

scores are expressed as percentages

Table 5.7. Mean nonword reading scores and scores on the Reading by Analogy Test

between scores in the cases of JS (Z = 1, P>.05), FW (Z = .2, P>.05) and WPB (Z = 1.5, P>.05). In the case of ZS performance was at zero on the Reading by Analogy Test; in the remaining cases where there is a significant difference between scores performance is better on the Reading by Analogy Test. However in view of the high proportion of lexicalisation errors made by some of these patients, it seems unlikely that this facilitatory effect of the provision of an analogous word reflects an inability to access a visually similar word when presented with a nonword. The results support the notion that it is possible to use alternative strategies for reading nonwords. The significant differences between scores indicate that the ability to use the different strategies can dissociate to a certain extent. ZS's inability to use the Reading by Analogy technique in conjunction with the observed facilitatory effect of the provision of an analogous word indicates that the Reading by Analogy task is not simply a less-demanding task since there is a clear double dissociation. These test results are not enlightening as regards the issue of whether orthographic or phonological segmentation of the words leads to the pronunciation of the nonwords. Whichever strategy is used, it appears that it is not used spontaneously but only in response to special instructions. If a test could be devised which ensured the use of orthographic segmentation procedures, an investigation of the extent to which the ability to use the two techniques (i.e. reading nonwords by analogy with words and reading nonwords via the phonological route) can dissociate would be an interesting subject for further research.

5.2.7 Summary regarding lexical analogy theory

The observed effect of type of nonword structure on reading performance in the Structured Nonwords Test and the lack of an effect of segmental consistency provide evidence to suggest that there is reliance on the impaired phonological route rather than the use of a lexical analogy strategy. An analysis of the error responses in a single subtest (H) of the Structured Nonwords Test and the nature of the relationship between nonword stimuli and lexicalisation responses provides further evidence for this conclusion. It is noted that the results of the Reading by Analogy tests are difficult to interpret in terms of lexical analogy theory but that these results suggest that alternative strategies for nonword reading are available.

5.3 Lexical and non-lexical reading impairments

5.3.1 Introductory comments

The symptoms associated with phonological dyslexia (discussed in Chapter Two) include characteristic impairments of word reading. Specifically these impairments are:

i) the occurrence of visual errors

ii) the occurrence of morphological errors

iii) the occurrence of a deficit in reading function words relative to content words.

It is concluded that these symptoms have not been shown to be necessary features of phonological dyslexia. The critical symptom of phonological dyslexia is impairment of nonword reading reflecting damage to the phonological route. No direct or indirect causal link between the critical symptom and lexical impairments has as yet been demonstrated. Published clinical reports have shown that no other symptom is invariably present in phonological dyslexia and the probability that no direct causal link between lexical symptoms and impaired ability to assembly phonology will be found is noted. However, one possible theoretically-motivated distinction relating to word reading has not always been considered in published reports. Patients may present with different patterns of word reading impairment according to whether they are relying on the direct or lexical-semantic route. The impairment of one or other lexical route is not causally related to the impairment of the phonological route so that no association between locus of lesion in the phonological route and reliance on a single lexical route is predicted. In the absence of evidence that assembled phonology plays a part in the reading of normal adults, it is not possible to conclude that the observed pattern of word reading results from the operation of a single lexical route in conjunction with an impaired ability to assemble phonology. Reliance on a single lexical route has been demonstrated in some the patients tested in this work and aspects of the sparing of a single lexical route are discussed in the following section.

5.3.2 The Direct and Lexical-Semantic Routes

5.3.2.1 The Direct route and the absence of a function word deficit

The tentative account of the function word deficit in phonological dyslexia put forward by Patterson (1982) proposes that the lexical-semantic route is not well suited to the processing of grammatical morphemes and that these morphemes may be processed by the phonological route. Hence a function word deficit is predicted when the phonological route is impaired. The case of WB (Funnell, 1983) who, though unable to read nonwords had no difficulty with reading functors poses problems for this account. The issue is fully discussed in Chapter 2 (Section 2.1.6) where the possibility that the direct route is intact in the case of WB is considered. If it is the case that the absence of a function word deficit is only observed in cases where the direct route is operative, the account proposed by Patterson is compatible with published accounts of phonological dyslexia. The function word deficit is related to the phonological impairment on this account and is a necessary symptom of certain types of phonological dyslexia.

The data presented in this work is not compatible with this account however. Table 5.8 summarises the effects of different variables on word reading performance. There is no evidence of a function word deficit in cases where the direct route is intact; such a deficit would be very difficult to explain in terms of the 3-route model. Note that JS reads difficult function words better than difficult content words. It is concluded that this is due to an effect of frequency. There are, however, three cases (CB, JS and PG) in which test results suggest reliance on the lexical-semantic route yet, in which there is no function word deficit. Thus impairment of the phonological route does not necessarily lead to a function word deficit if the direct route is not operational. The function word deficit when it occurs presumably results from an additional impairment within the lexical-semantic route; and the data strongly suggest that function words are not normally processed by the phonological route. There is a caveat, however. All three patients who appear to rely on the lexical-semantic route but do not show a function word deficit have some residual ability to use the phonological route which may block function word confusions.

5.3.2.2 The direct route and derivational errors: the locus of the morphological decomposition system

The implications of the occurrence of derivational errors in patients in whom the direct route is operational is noted in Chapter 1 (Section

Patient	Route[a] in Use	Function/ Content	Noun/Verb	Presence of suffix	Concreteness or Imageability	Frequency	Length
DA	LS	+	+	-	+	-	-
DP	D?	-	-	+?	-?	-	-
TW	D	-?	-	-	-	-	-
CB	LS	-	-	+	-	-	-
JS	D	+[b]	-	-	-	-	-
ZS	LS	-	-	-	+?	-	-
PG	LS	-	-	-	+	-	-
FW	LS	+?	-	-	+?	-	na
WPB	D	-	-	-	-	-	-

Table 5.8 Variables affecting word reading

Notes for Table 5.8

a D = Direct
LS = Lexical-Semantic
b Function words being better than content in the difficult test
? indicates that the effect is not unequivocally present/absent (see individual case reports for discussion)
na not administered.

1.3.1.2.1) discussed in the case reports. Such errors would provide evidence for a morpheme-based visual word recognition system. The data presented here however is not enlightening on this point. Table 5.9 summarises the main types of error present in the error corpora. Three patients (TW, JS and WPB) rely on the direct route for word reading. It is possible that DP relies on this route but the evidence is equivocal in this case. Unfortunately, it has not been possible to demonstrate that derivational/inflectional errors occur as a genuine category of error in any of these cases. In each case, there is conflicting evidence. These error types may account for a fairly high proportion of total errors but the patient may not be sensitive to the presence of a suffix. This is so in the case of WPB although there is additional evidence that the errors do form a genuine category since significantly more derivational than inflectional errors occur. However error totals in these categories are very low. It is clear that the errors do not form a genuine category in the case of JS and probable that they do not in the case of TW. In the case of DP the reliance on the direct route as well as the presence of derivational/inflectional errors is open to question. Thus, on the basis of evidence presented in this work, there is no reason to alter the model presented in Chapter 1 (Fig 1.5) which locates the morphological decomposition system within the lexical-semantic route.

There is not invariably uncertainty about derivational and inflectional error categories. In the cases of DA and CB there is no doubt that these are genuine error categories. Such errors account for relatively high proportions of total errors and in each case the number of inflectional and the number of derivational errors differ signficicantly. In fact, these two cases validate the distinction between inflectional and derivational errors since DA makes a significantly higher number of inflectional and CB a significantly higher number of derivational errors. CB's reading performance is significantly affected by the presence of a suffix; DA reads more unsuffixed than suffixed words although because of low scores on both subtests, this difference does not reach significance.

5.3.2.3 The lexical-semantic route and the imageability effect

Sartori et al.'s (1984) statement that there is no effect of

Patient	Route[a] in use	Visual	Derivational/ Inflectional	Function word Substitution	Semantic	Other	Omission
DA	LS	+	+	+	+	+	+
DP	D?	+	+	few	-	+	few
TW	D	+	-?	few	1	+	few
CB	LS	+	+	few	1	+	few
JS	D	few	-	1	-	phonemic paraphasia	-
ZS	LS	+	+	few	-	+	few
PG	LS	+	-?	few	few	phonemic paraphasia	few
FW	LS	+	+?	few	-	+	+
WPB	D	+	+?	few	-	+	-

Table 5.9 <u>Type of word reading error</u>

<u>Notes for Table 5.9</u>

a D = Direct
  LS = Lexical-Semantic
? indicates that the effect is not unequivocally present/absent (see individual case reports for discussion)

imageability in cases of phonological dyslexia has already been queried (Chapter 2, Section 2.1.8). The case of PG provides another example of a case of phonological dyslexia in which there is an effect of this variable. A somewhat less clear effect of the variable is observed in the cases of ZS and FW (see Table 5.8) who performed better on high-imageable items in the difficult but not the easy Imageability Test.

As predicted in Chapter 2, an effect of this variable is not observed in patients who rely on the direct route for reading aloud. It was noted in Chapter Two that the majority of reported cases of phonological dyslexia do not show an imageability effect and that this fact and the observation of a case in which performance is better on low-imageable stimuli (Warrington, 1981) suggest that reduced performance on low-imageable items is not a normal characteristic of reliance on the lexical-semantic route. The possibility of reliance on the direct route in cases of phonological dyslexia in which there is no imageability effect is considered. CB's reading pattern provides evidence to support the original hypothesis that the imageability effect results from an additional deficit in the lexical-semantic route. CB relies on the latter route for word reading (as evidenced by comprehension which is at times superior to reading aloud) but shows no effect of imageability.

It is also of interest to note that in the case of JS who relies on the direct route for word reading, there is no effect of imageability in reading tasks. That there is an impairment within the lexical-semantic route is demonstrated by the strong effect of imageability on performance in a comprehension task (the Synonym Matching Test). The latter impairment has no effect on the operation of the direct route and nicely demonstrates the autonomy of the two routes.

A further theoretical issue raised in Chapter 2 (Section 2.1.6) is that of the possible relationship between the imageability and part of speech effects. It has been suggested (Allport and Funnell, 1981) that the part of speech effect is in fact a manifestation of the imageability effect. The independence of the two variables is demonstrated by the reading pattern of PG who is clearly sensitive to imageability but not to part of speech.

5.3.2.4 The lexical-semantic route and semantic errors

DA, the patient who shows the characteristic "deep dyslexic" reading pattern is the only patient reported in this work who makes a significant number of semantic errors. The observation that the other four patients who rely on the lexical-semantic route (see Table 5.9) do not make errors of this type, provides evidence additional to that already available in the literature (See Chapter 2, Section 2.1.7) that semantic errors result from an additional impairment in the lexical-semantic route and do not reflect a fundamentally unstable system.

5.3.3 The severity of the nonword reading impairment and the function word deficit

5.3.3.1 Function words in isolation

It is noted (see Section 5.3.2.1) that the data presented in this work suggests that there is no causal link between impairment of the phonological route and the presence of a function word deficit. However, since all three patients who rely on the lexical-semantic route but do not show a function word deficit in single word reading tests have some residual ability to use the phonological route, a caveat is added to the effect that minimal phonological coding may block function word confusions. This possibility was investigated by computing a rank order correlation coefficient (Kendall's S) between severity of nonword reading impairment and function word errors on single words in patients in whom the direct route is not functional.

The measure of severity of the nonword reading impairment was a "discrepancy score" obtained by subtracting the percentage of nonwords read correctly from the percentage of words read correctly on matched word/nonword tests[5]. The figure for function word errors was obtained by subtracting the percentage of errors made on content words from the number made on function words in the Easy and Revised Part of Speech Tests (the Difficult Test was not administered to all patients). If function word errors exceed content word errors, this figure is positive; if the reverse is true, the figure is negative. A figure of zero represents equal proportions of function and content word errors. The use of these measures ensures that the correlation is not affected by overall level of impairment.

Table 5.10 shows the discrepancy score (for all patients regardless of lexical route used), the figure for function word errors in single word tests and a figure for function word errors in text (see following section).

Figure 5.2 shows the relationship betwen the discrepancy score and proportion of function word errors for patients relying on the lexical-semantic route (DP is not included in this calculation since there is some uncertainty about the route used in this case). Figure 5.3 shows the same relationship for all patients and is included for the purpose of comparison with the relationships between the discrepancy score and the measure of function word errors in text. In neither case does Kendall's S reach significance. In the first analysis (Figure 5.2) $S = -6$, $P > .05$. In the second analysis (Figure

5.3) $S = 6$, $P > .05$. In neither case is there any evidence that the severity of the nonword reading impairment has any effect on the ability to read single function words relative to single content words presented in isolation.

Patient	Route in use	Word/Nonword discrepancy figure	Percentage of function word errors in single word tests	Percentage of function word errors in text
--				
DA	LS	35	+23	+14
DP	D?	74	+19	+23
TW	D	84	+11	+38
CB	LS	58	+11	+ 3
JS	D	37	-25	- 9
ZS	LS	74	+ 5	+ 7
PG	LS	60	- 2	+ 4
FW	LS	50	+10	- 3
WPB	D	29	0	- 2

Table 5.10 The severity of the nonword reading impairment and the percentage of function word errors in isolation and in text

5.3.3.2 **Function words in text**

5.3.3.2.1 **The presence of a significant correlation between errors on function words and the severity of the nonword reading impairment**

A separate analysis was carried out using a measure of function word errors in text obtained by subtracting the percentage of errors made on content words from the number made on function words in the passage of text. As with the measure of function word errors in isolation a

Fig.5.2 The severity of the nonword reading impairment and the percentage of function word errors on single words:lex-sem. group

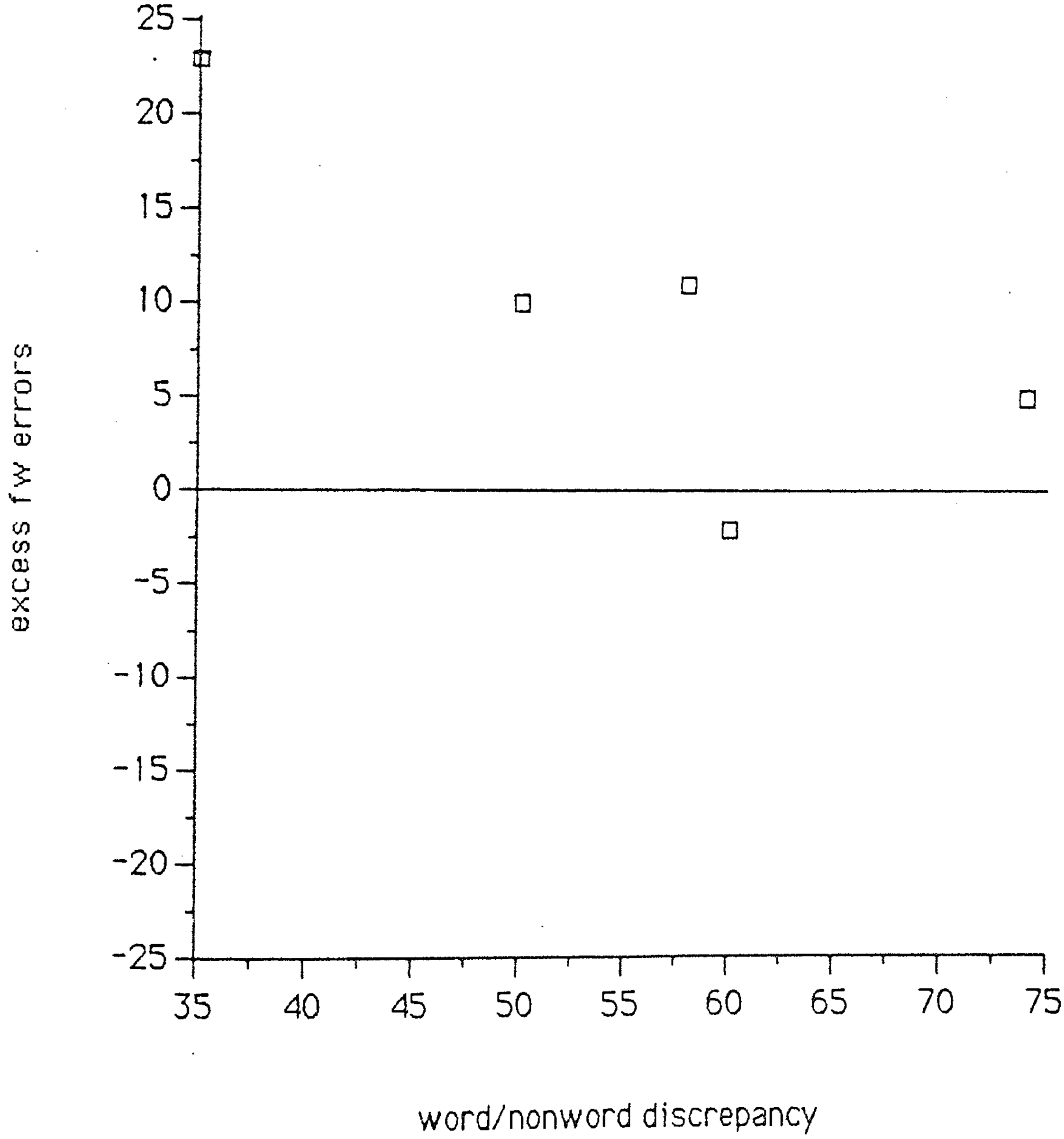


Fig.5.3 The severity of the nonword reading impairment and the percentage of function word errors on single words: all patients

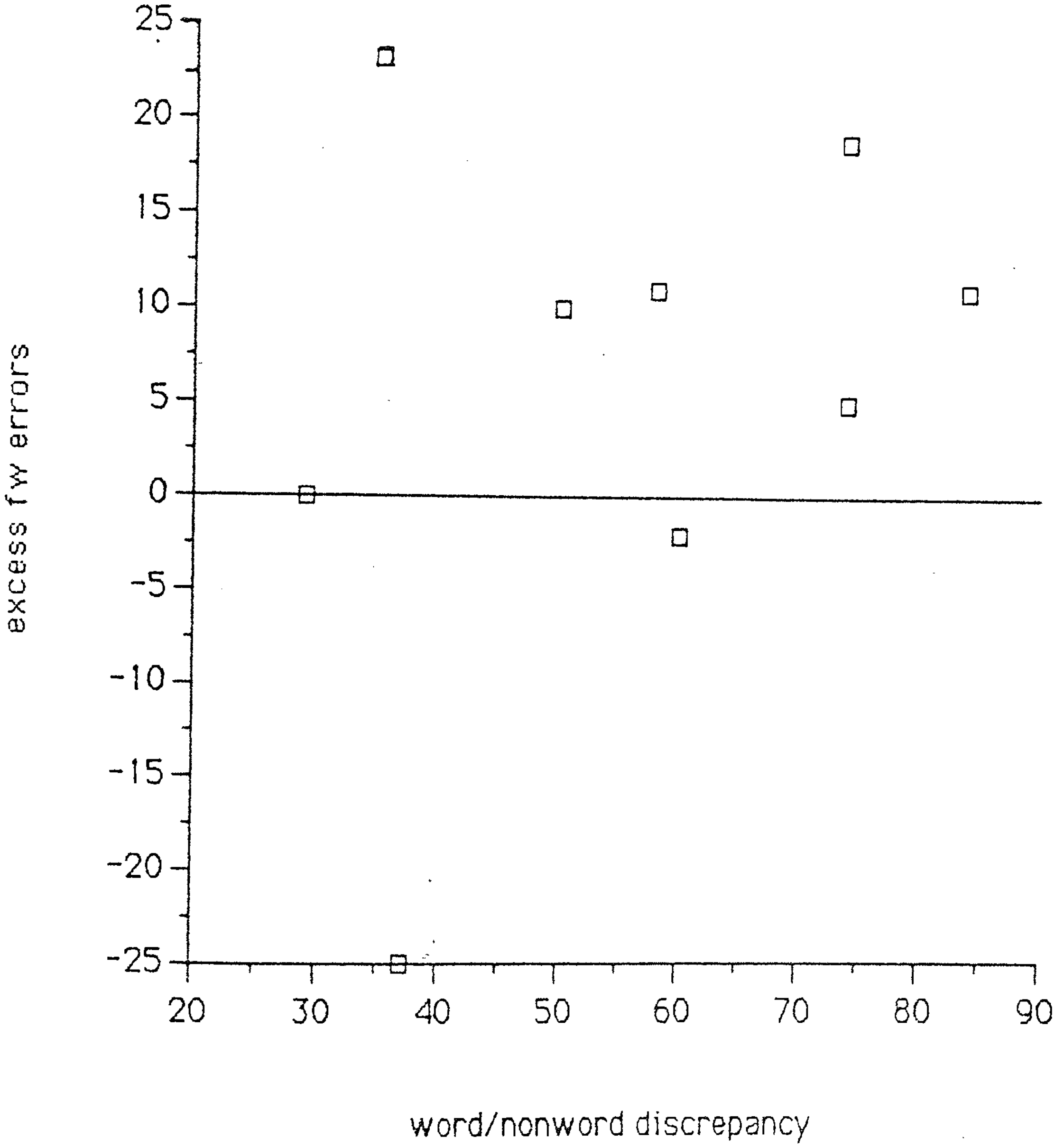
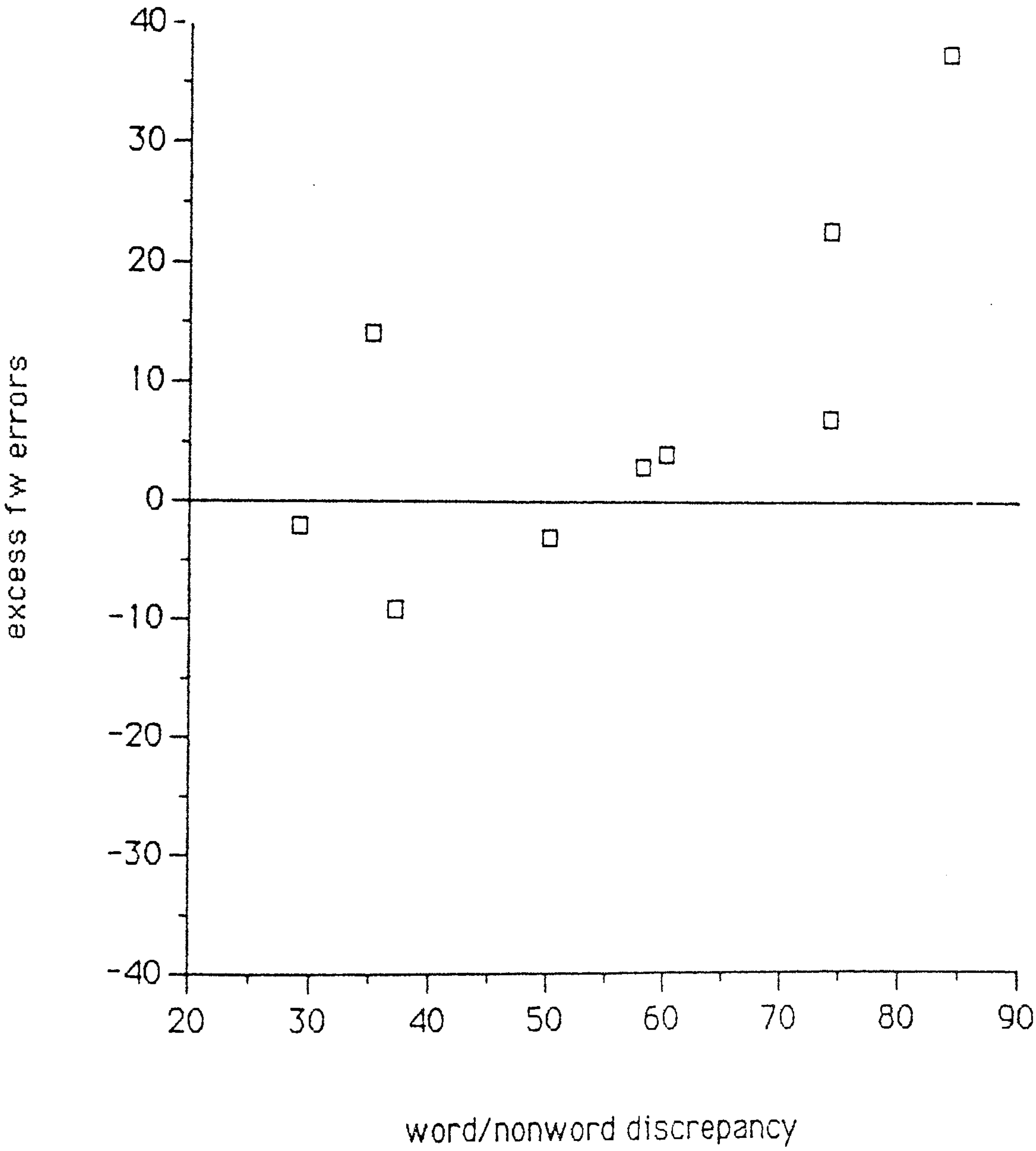


Fig.5.4 The severity of the nonword reading impairment and the percentage of function word errors in text:all patients



positive sign indicates that function word errors exceed content word errors and a negative sign that the reverse is true. A figure of zero represents equal proportions of function and content word errors. Figure 5.4 shows this relationship. There is a significant positive correlation in this case ($S = 21$, $P < .05$). Thus the more severe the impairment to the phonological route (and hence the larger the discrepancy figure), the higher the number by which the percentage of errors on function words exceeds the percentage of errors on content words in text.

There is no correlation between the overall percentage of errors made in reading text and the severity of the nonword reading impairment (Kendall's $S = 6$, $P > .05$). The percentage of text reading errors made by each patient is shown in Table 5.11.

Patient	Word/Nonword discrepancy figure	Percentage of text reading errors
DA	35	58
DP	74	62
TW	84	30
CB	58	9
JS	37	8
ZS	74	14
PG	60	8
FW	50	7
WP	29	10

Table 5.11 The severity of the nonword reading impairment and the percentage of text reading errors

5.3.3.2.2 An account of the relationship between severity of impairment to the phonological route and the occurrence of function word errors in text

The use of different strategies in text and single-word reading is discussed in Chapter 2 (Section 2.1.6. It has been suggested (Allport, 1979; Vallar and Baddeley, 1984) that phonological coding may be implicated in the comprehension of text in connection with short term memory storage necessary for the analysis of larger syntactic units. Such involvement of phonological coding in reading text would not alone explain the correlation of phonological impairment with function word errors in text. The account as it stands in fact predicts that the overall percentage of errors in reading text should increase as phonological impairment increases. This is not the case (see Table 5.11). There is no evidence of correlation between these two variables.

A high semantic involvement in reading text has been suggested by Patterson (1982) in discussion of the tendency shown by normal readers to make more errors on function than content words in speeded oral reading. It is clear that the direct route is of little value in text reading if the subject is reading for comprehension. However, if this account is to explain the observed correlation between phonological impairment and function word errors, an additional requirement is that normal readers make use of phonological coding in text reading and that the involvement of this route tends to block errors to a certain extent. It is important to note that the increased rate of function word errors reported by Morton (1964a) occurred when speeded reading was required. The phonological coding process may require more time than is available in speeded reading tasks. When phonological coding cannot be used because of time constraints or because of an impairment of the phonological route, the possibility of error increases. When the lexical-semantic route is in use, function words are more likely to elicit errors than are content words if grammatical morphemes are indeed less well-specified within the semantic system.

A problem for this account is the lack of correlation between the percentage of function word errors made in single word tests by patients relying on the lexical-semantic route and degree of phonological impairment (see Section 5.3.3.1). If errors are due to the operation of the lexical-semantic route in isolation without phonological back-up when function words are read in text, a similar mechanism should produce function word errors when words are presented singly if there is no involvement of the direct route. The sample of patients in the analysis of this relationship is very small and it may be that a correlation would be found if data were collected from a larger sample. However, the figure for S is negative, so that there is no question of the value of S even approaching significance with regard to the expected positive correlation.

The data suggest that there is functional interdependence between the ability to read grammatical morphemes and the ability to assemble phonology in certain types of task. The correlation observed in text reading requires more detailed explication but the area is one in which further research is required before firm conclusions regarding the reason for the correlation can be reached.

5.3.3.3 **Derivational errors in isolation and in text**

Table 5.12 shows the percentage of derivational errors in the total error corpus of each patient and the percentage of content words in the passage of text which elicited a derivational error. There is no correlation between the number of single word derivational errors and the degree of phonological impairment as measured by the discrepancy figure (for the group of five patients using the lexical semantic group S = -2, P>.05; for the full group S = -2, P>.05). There is a positive correlation between the percentage of derivational errors in text and the discrepancy figure (S = 18, P<.05). These relationships are shown in Figures 5.5, 5.6 and 5.7. This pattern is identical to the pattern observed in the reading of function words and the account given of the correlation between phonological impairment and function word reading ability in text is applicable to the correlation between phonological impairment and percentage of derivational errors in text.

Patient	Word/Nonword discrepancy figure	Percentage of derivational errors on single words	Percentage of derivational errors in text
DA	35	26	0
DP	74	20	14
TW	84	17	11
CB	58	39	7
JS	37	4	0
ZS	74	18	4
PG	60	8	4
FW	50	32	4
WPB	29	18	4

Table 5. 12 The severity of the nonword reading impairment and the percentage of derivational errors in isolation and in text

Fig.5.5 Nonword reading and inf/der errors on single words;lex-sem. group

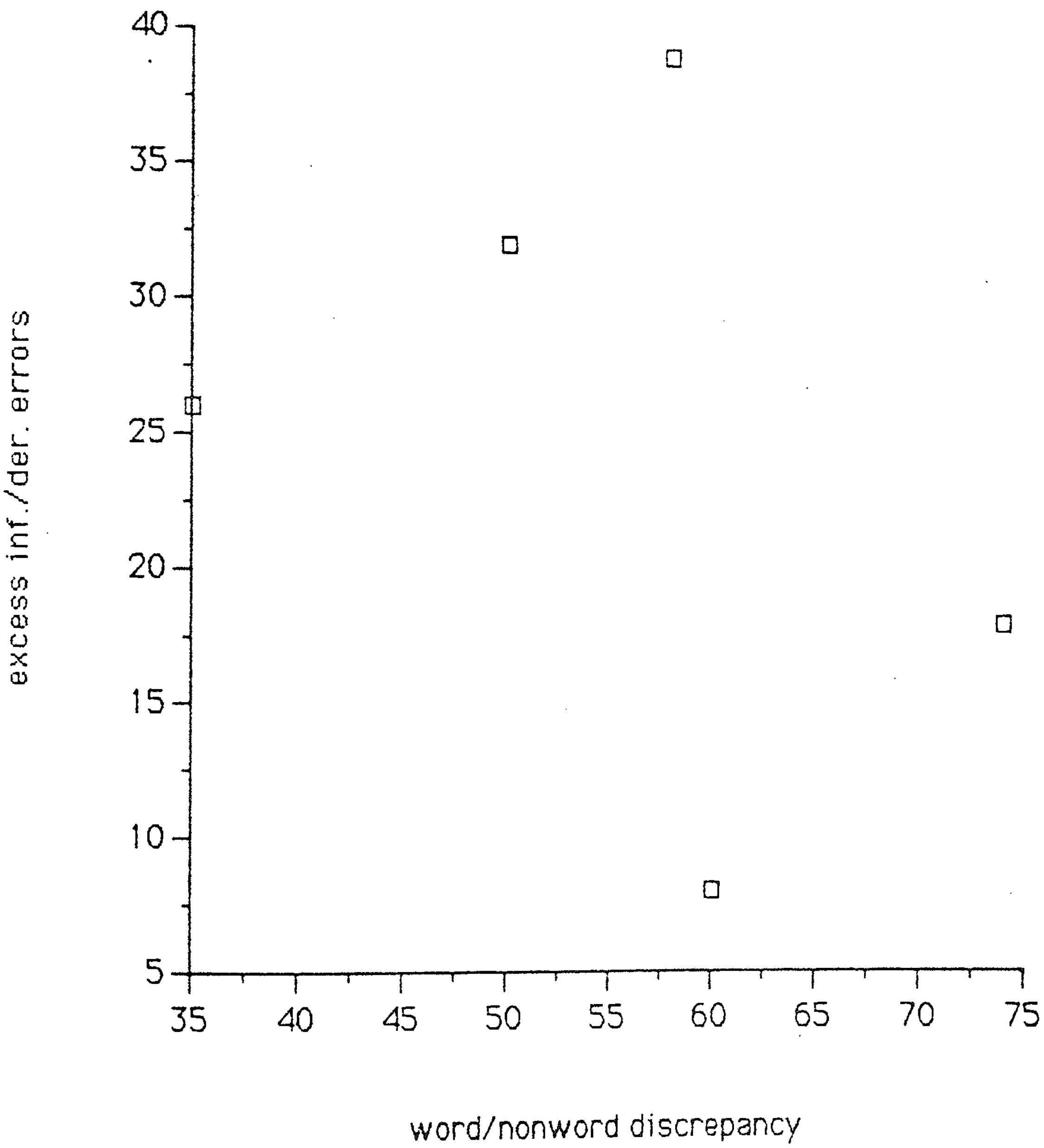


Fig.5.6 Nonword reading and inf./der. errors on single words:all patients

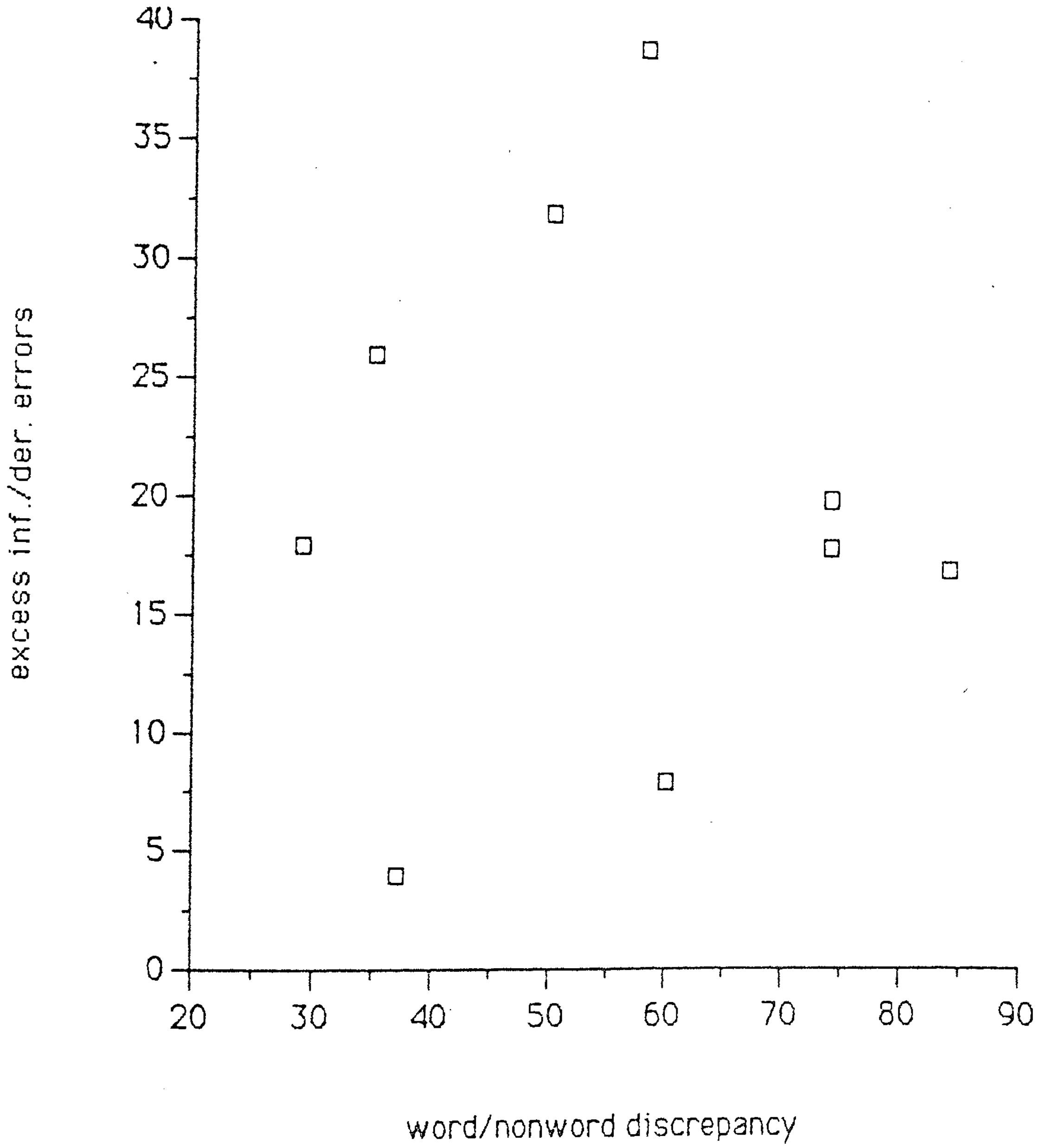
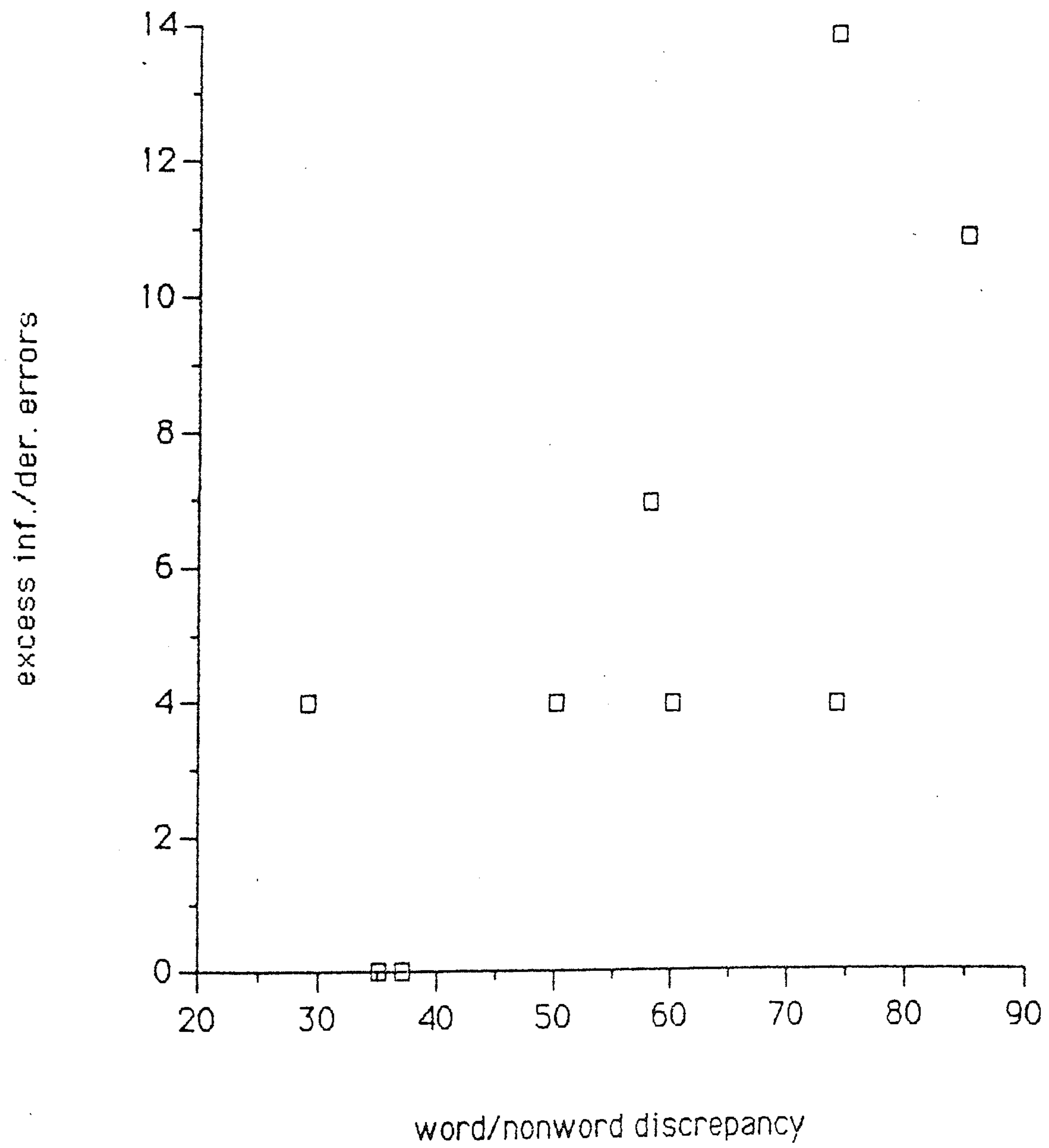


Fig.5.7 Nonword reading and inf/der errors in text:all patients



5.3.4 Summary and conclusions regarding lexical and non-lexical reading impairments

Patients who present with impaired nonword reading may rely on the direct or the lexical semantic route for word reading. Use of the lexical-semantic route does not imply the occurrence of semantic errors, the presence of an imageability effect or the presence of a function word deficit when single word items are presented for reading. Neither a function word deficit on single words nor an imageability effect is observed in cases where the direct route is operational. This state of affairs is as predicted by the standard model since the direct route is independent of the semantic system.

The severity of the impairment of nonword reading is related to the number of function word and morphological errors made in reading text, the number of errors increasing with the severity of the impairment. There is no such relationship between the severity of the impairment of nonword reading and the number of function word errors and morphological errors in single-word tests. A possible account in terms of high involvement of the lexical-semantic route in text reading in conjunction with the use of phonological coding which tends to block errors in the case of normal readers is discussed. The presence of the correlation suggests that poor performance on function words in text and the occurrence of morphological errors in text may need to be considered as necessary symptoms of phonological dyslexia in cases in which the phonological route is very severely impaired. It would appear that limited ability to make sub-lexical grapheme-phoneme conversions suffices to block such errors in reading text aloud.

5.4. Laterality, site of lesion and associated symptoms

The possible significance of accompanying dysphasia and dysgraphia in cases of acquired dyslexia are discussed in Chapter 2 (Section 2.1.10) where it is concluded that, in spite of Sartori et al.'s (1984) inclusion of these disorders as associated symptoms of acquired phonological dysgraphia, it is unlikely that a return to such classification by associated disorders would prove useful. Site of lesion is recorded where possible in published clinical case reports but specific information about site of lesion is often not available and so far no pattern of association of lesion site and sub-type of dyslexia has emerged. Handedness in phonological dyslexia has been mentioned by Temple and Marshall (1983) who note that "to date a disproportionately high number of acquired phonological dyslexics are left-handed. .... It may be that these patients are frequently found within a particular neurological subpopulation with atypical brain organization."

Table 5.13 shows the hemisphere damaged, handedness, type of aphasia and presence of dysgraphia for the phonological dyslexic patients reported in this work. The table is included for comparison with Table 2.1 (Chapter 2). It is interesting to note, in relation to Temple and Marshall's suggestion regarding atypical brain organization that all these patients are dextrals as are the majority of patients from whom data is collated in Table 2.1. Unfortunately, information regarding site of lesion was frequently not available and the data in Table 5.13 does not address the issue of consistency of lesion site. Dysgraphia is present in all patients, although pre-morbid writing of English was poor in the case of ZS. As indicated in Table 2.1, type of dyslexia and type of aphasia clearly dissociate. Table 5.13 shows that phonological dyslexia can occur in association with fluent or non-fluent aphasias (a more precise classification of type of aphasia is given where possible) or in the absence of aphasia.

Patient	Hemisphere damaged	Handedness	Aphasia	Dysgraphia
DA	L	R	Broca's	+
DP	L?	R	Broca's	+
TW	L	R	NF	+
CB	L	R	NF	+
JS	L?	R	Transcortical Sensory	+
ZS	L?	R	F	?*
PG	L?	R	Conduction	+
FW	L?	R	Anomic	+
WPB	?	R	None	+

Table 5.13 Hemisphere damaged, handedness, aphasia and dysgraphia

L = Left
R = Right
F = Fluent
NF = Non-fluent
? data not available; queried hemisphere indicates a diagnosis made on the basis of the clinical picture.
?* ZS appears to be dysgraphic but this may not be an acquired disorder since his pre-morbid writing of English was poor.

In conclusion, information on handedness, site of lesion, aphasia and dysgraphia is summarised. It is concluded that these data confirm conclusions already reached in discussion of published cases of phonological dyslexia regarding neurological data and associated disorders. In particular, it is of note that phonological dyslexia occurs in the context of different types of aphasia. There is no evidence to suggest that the presence of a given variety of aphasia predicts the presence of a particular variety of dyslexia.

5.5 Implications for therapy and suggestions for further research

The precise specification of the operations which patients with acquired reading disorders cannot perform is made possible by the use of the Structured Nonwords Test. This test enables the therapist to identify the skills which require reteaching or alternatively, and where possible, to develop strategies in which lost skills are by-passed.

However, the desirability of reteaching phonological skills depends upon the part which such skills play in the normal reading process. In itself, loss of the ability to read nonsense syllables and unfamiliar words is not a particularly serious problem for the adult who has suffered neurological insult. There is evidence to be found in the literature which suggests that sub-lexical grapheme-phoneme conversion plays little or no part in the reading of normal adults (see Chapter 1, Section 1.3.1.1 for discussion) and it is arguable that the present research findings are of more relevance to the development of cognitive models of the normal reading process than to the treatment of the neurologically impaired.

In view of this uncertainty about the role of phonological coding in the normal reading process, the observed correlation between the severity of the nonword reading impairment and the number of function word and morphological errors made in reading text aloud merits further investigation and explication.

An additional question arising out of the present work is that of the extent to which the ability to read nonwords by a process of lexical analogy dissociates from the ability to read nonwords via the independent phonological route as specified in the standard model. If these abilities do dissociate then there will be cases in which the patient may be encouraged to use lexical analogy strategy (when it is not used spontaneously) and when the use of this alternative strategy will be helpful in remediation of the reading disorder.

5.6 Varieties of acquired phonological dyslexia: Final Statement

Evidence is presented to support the hypothesis that subsystems in the phonological route may be selectively impaired and that different patterns of nonword reading behaviour reflect impairment of the different subsystems or impairment of combinations of subsystems. Two cases of a subtype of phonological dyslexia in which the Phoneme Allocation system is the primary locus of impairment and two cases in which the Resegmentation System is the primary locus of impairment are reported. In a further case, the Phoneme Allocation Sytem is impaired in conjunction with the Blender. Three cases in which it is argued that the almost total lack of output from the phonological route is the result of a lesioned pathway in this route are presented.

Lexical reading impairments vary independently of the locus of impairment in the phonological route and, apart from the processing of grammatical morphemes in reading aloud text, are independent of the severity of the impairment to the phonological route. The presence of a correlation between the number of function word and morphological errors in text reading and the severity of the nonword reading impairment suggests a more complex involvement of phonological recoding in the processing of text than has hitherto been suggested (e.g. Vallar and

Baddeley, 1984) since the severity of the nonword reading impairment does not correlate with the total number of errors made in reading text.

The data provide further evidence for the existence of the direct route. Different patterns of word reading performance occur in phonological dyslexia according to whether the direct or the lexical-semantic route is operational.

Notes for Chapter 5

1 It should be noted that impairment of the Resegmentation System is not only found in the context of phonological dyslexia. Newcombe and Marshall (1984) describe a case of surface dyslexia in which the Resegmentation System is impaired.

2 The items assigned to each category are shown below:

Consistent	Inconsistent	Do not form word-final segment
eap	ead	noo
oid	ood	voe
aif	eaf	oum
eem	tood	oab
oin	doad	aum
oom	keak	aup
oal	ush	zie
oam	ath	eeb
naud	oth	auf
lail	ush	paip
maut	ath	taum
yeed	fush	eth
soam	nath	eth
meap	poth	
feep	dush	
aud	dath	
roid		
deek		
keem		
yoam		
peam		
feem		
leam		
uth		
eck		
ith		
ish		
esh		
ack		

eck
ith
ish
ick
dack
shap
thut
huck
shum
shen
thip
fick
shan
thup
bick
shom
sheb
thad
rith

3 These error responses are: JS: obe -- / oʊbi /, epe -- / ɛpi/ ; ZS: obe --/ oʊbi /; PG: ave --- / ævi /; WPB efe -- /ɛfi/ .

4 CB's error responses are:
afe --/æfi /; obe --/ oʊbi /; ove -- / oʊvi/, ede, -- / idi/, ave -- /ævi /; ebe -- / ɛbi/; efe -- / ɛfi /, epe -- / ɪpi -; aze -- / ɛɪzi/.

5 The "mean nonword reading score" is used as an indication of level of nonword reading performance in preference to the total nonword reading score given in the Nonword Reading errors section of each case report. The latter figure may be misleading since patients who were better at reading nonwords were given difficult tests which were not given to patients who were very poor at reading nonwords. Thus the total figure tends to augment the severely impaired patients' score by comparison with the scores of the less severely impaired patients. Furthermore, comparisons of word and nonword reading performance are more informative if words and nonwords are matched for length and structure. The "mean nonword reading score" is obtained by adding the scores on the Reading Easy Lexical Decision Test (Nonwords) and the subtests of the Structured Nonwords Test which are matched with real words (see Chapter Three, Section 1.5.2) and

expressing the total as a percentage of nonwords in these tests. The scores on words in these tests are added in the same way to give the "mean word reading score".

6 Responses classified as omissions are not included in the "Total Errors" figure.

APPENDIX I

THE BOSTON DIAGNOSTIC APHASIA EXAMINATION SUBTEST SUMMARY SCORES FOR PATIENTS DISCUSSED IN CASE REPORTS I TO IX AND WHURR PERFORMANCE PROFILE FOR IC (CASE REPORT X).

SUBTEST SUMMARY PROFILE

NAME: DA

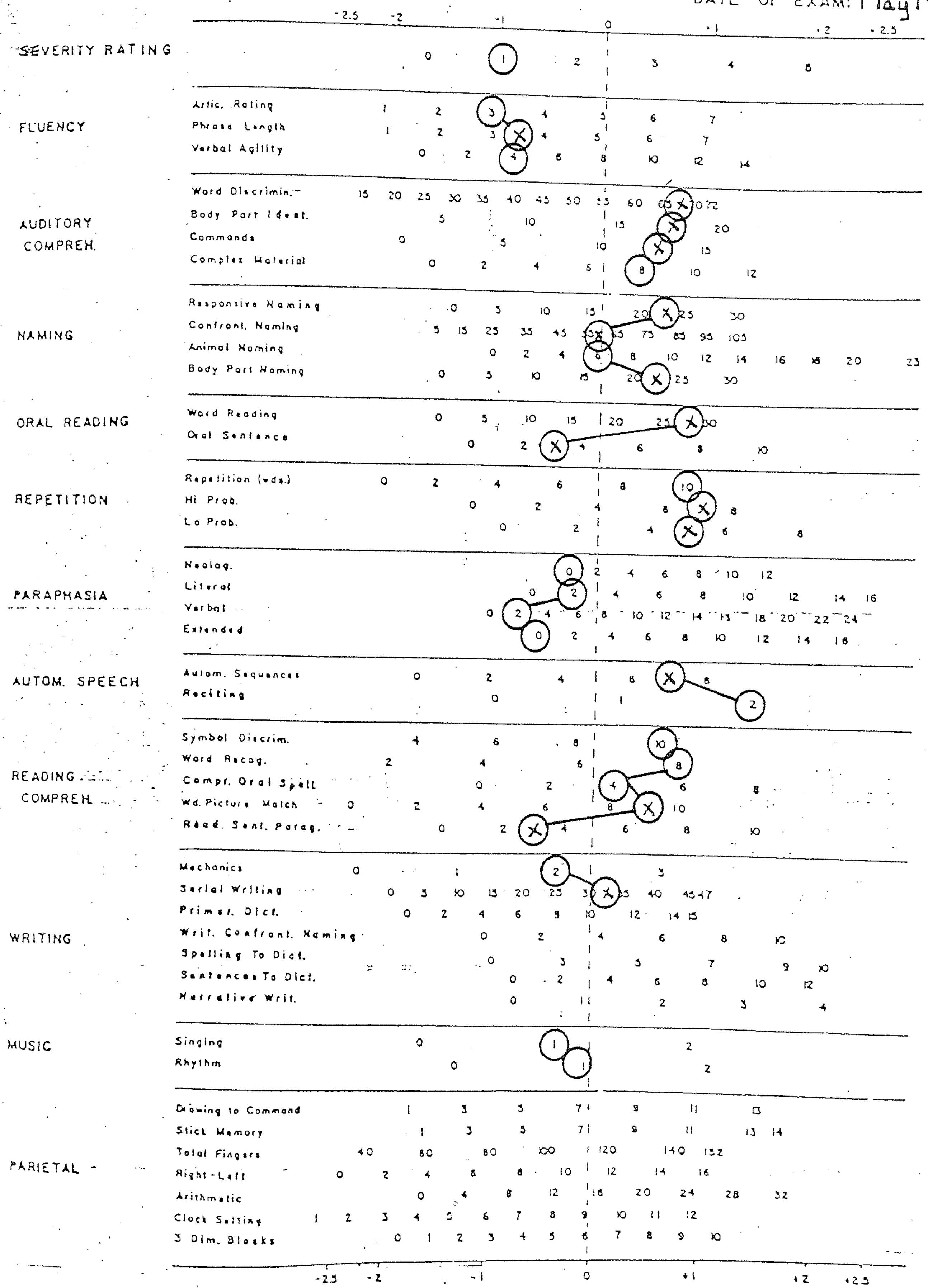
DATE OF EXAM: June 1984

	PERCENTILES:	0	10	20	30	40	50	60	70	80	90	100
SEVERITY RATING			0	1				2		3	4	5
FLUENCY	ARTICULATION RATING		1	2	4	5	6		7			
	PHRASE LENGTH			1	3	4	5	6	7			
	MELODIC LINE		1	2	4		6	7				
	VERBAL AGILITY		0	2	5	6	8	9	11	13	14	
AUDITORY COMPREHENSION	WORD DISCRIMINATION	0	15	25	37	46	53	60	6 X	67	70	72
	BODY-PART IDENTIFICATION	0	1	5	10	13	15	16	17	18	X	20
	COMMANDS	0	3	4	6	8	10	X	13	14	15	
	COMPLEX IDEATIONAL MATERIAL		0	2	3	4	5	6	8	9	11	12
NAMING	RESPONSIVE NAMING			0	1	5	10	X 15	20	24	27	30
	CONFRONTATION NAMING		0	9	X	53		72	84	94	105	114
	ANIMAL NAMING				0	1	2	3	4	6	X	23
ORAL READING	WORD READING			0	1	4	X 7	15	21	26	30	
	ORAL SENTENCE READING					0	1	2	4	7	9	10
REPETITION	REPETITION OF WORDS		0	2	5	7	8		9		10	
	HIGH-PROBABILITY			0	1		2	4	5	7	8	
	LOW-PROBABILITY					0	1		2	4	6	8
PARAPHASIA	NEOLOGISTIC	40	16	9	4	2	1		0			
	LITERAL	47	17	12	9	6	5	1	2	1	0	
	VERBAL	40	23	18	15	12	9 X	7	4	3	1	0
	EXTENDED	75	12	5	3	1	0					
AUTOMATIC SPEECH	AUTOMATIZED SEQUENCES		0	1	2	3	4 X	6	7		8	
	RECITING				0	1				2		
READING COMPREHENSION	SYMBOL DISCRIMINATION	0	2	5	7	8	9		10			
	WORD RECOGNITION	0	1	3	4	5	6	7		8		
	COMPREHENSION OF ORAL SPELLING				0			3	4	6	7	8
	WORD-PICTURE MATCHING		0	1	4	6	8	9		10		
	READING SENTENCES AND PARAGRAPHS		0	1	2	3	4	5	6	7	8	10
WRITING	MECHANICS	1		2		3		4			5	
	SERIAL WRITING		0	7	18	25 X	30	33	40	43	46	47
	PRIMER-LEVEL DICTATION		0	1	4	6	9	X	13	14	15	
	SPELLING TO DICTATION					0	1	2	3	5	7	10
	WRITTEN CONFRONTATION NAMING				0	1	2	3	6	7	9	10
	SENTENCES TO DICTATION						0	1	3	6	8	12
	NARRATIVE WRITING		0	1			2			3	4	5
MUSIC	SINGING		0	1		2						
	RHYTHM		0	1				2				
SPATIAL AND COMPUTATIONAL	DRAWING TO COMMAND	0	6	7	8	9	10	11	12		13	
	STICK MEMORY	0	3	4	6	7	8	9	10	11	13	14
	3-D BLOCKS		0	2	4	5	6	7	8	9	10	
	TOTAL FINGERS	0	54	70	81	93	100	108	120	130	141	152
	RIGHT-LEFT	0	1	3	4	6	8	9	11	14	16	
	MAP ORIENTATION	0	2	5	6	9	11	13		14		
	ARITHMETIC		0	2	4	8	11	14	17	21	27	32
	CLOCK SETTING	0	3	4	6		8	9	10	12		
		0	10	20	30	40	50	60	70	80	90	100

Z-SCORE PROFILE OF APHASIA SUBSCORES

NAME: DP

DATE OF EXAM: May 1983



SUBTEST SUMMARY PROFILE

NAME: TW

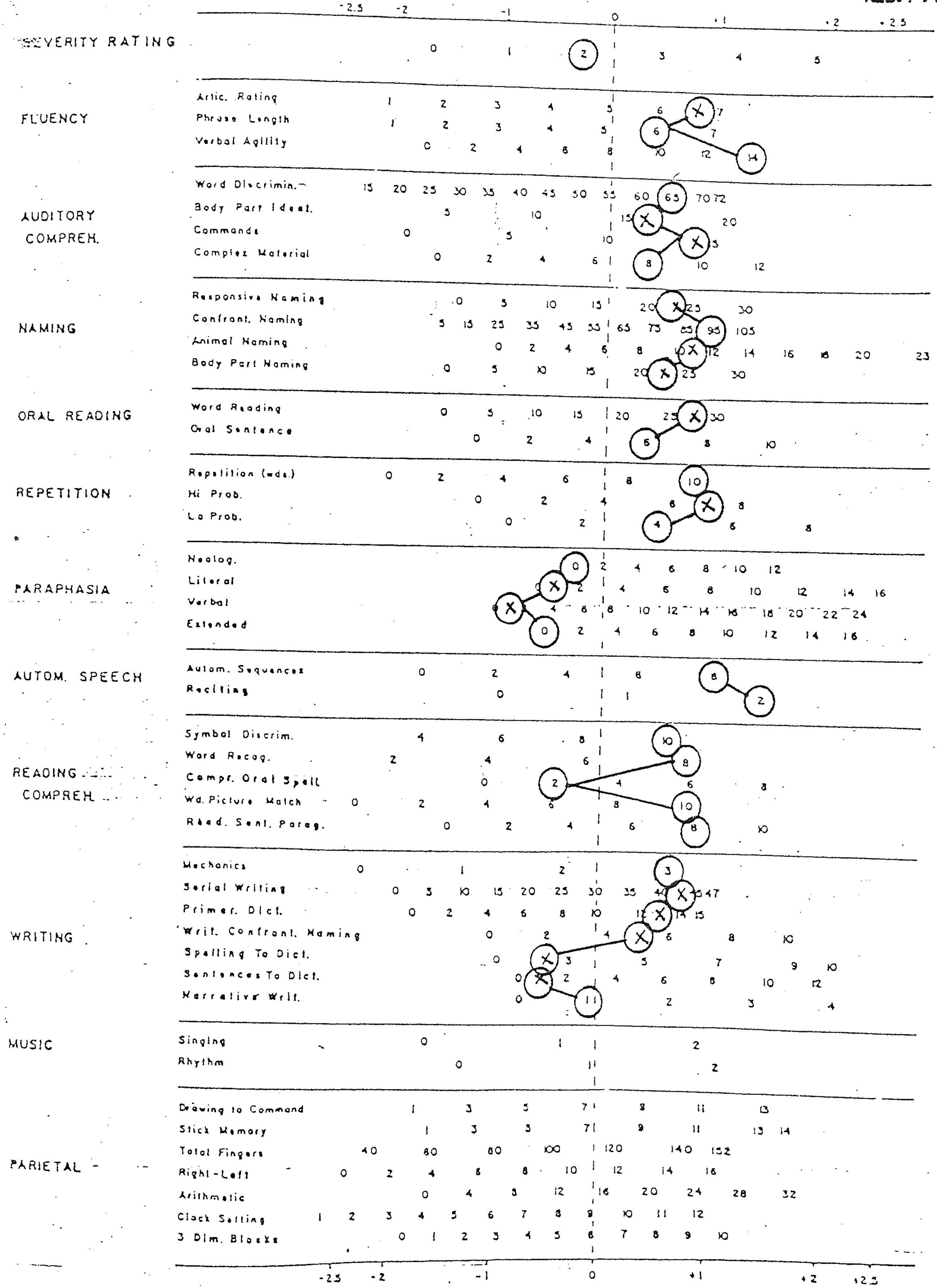
DATE OF EXAM: June 1984

PERCENTILES:		0	10	20	30	40	50	60	70	80	90	100
SEVERITY RATING			0	1				2		3	4	5
FLUENCY	ARTICULATION RATING		1	2	4	5	6		7			
	PHRASE LENGTH			1	3	4	5	6	7			
	MELODIC LINE		1	2	4		6	7				
	VERBAL AGILITY		0	2	5	6	8	X	11	13	14	
AUDITORY COMPREHENSION	WORD DISCRIMINATION	0	15	25	37	46	53	60	64	67	70	72
	BODY-PART IDENTIFICATION	0	1	5	10	13	15	16	17	18		20
	COMMANDS	0	3	4	6	8	10	11	13	14	15	
	COMPLEX IDEATIONAL MATERIAL		0	2	3	4	5	6	8	9	11	12
NAMING	RESPONSIVE NAMING			0	1	5	10	15	20 X	24	27	30
	CONFRONTATION NAMING		0	9	28	43	60	72	84	X 94	105	114
	ANIMAL NAMING				0	1	2	3	4	X	9	23
ORAL READING	WORD READING			0	1	3	7	15	21	26 X	30	
	ORAL SENTENCE READING					0	1	2	X	7	9	10
REPETITION	REPETITION OF WORDS		0	2	5	7	8		9		10	
	HIGH-PROBABILITY			0	1		2	4	5	7	8	
	LOW-PROBABILITY					0	1		2	4	6	8
PARAPHASIA	NEOLOGISTIC	40	16	9	4	2	1		0			
	LITERAL	47	17	12	9	6	5	3	2	1	0	
	VERBAL	40	23	18	15	12	9	7	4	3	1	0
	EXTENDED	75	12	5	3	1	0					
AUTOMATIC SPEECH	AUTOMATIZED SEQUENCES		0	1	2	3	4	6	7		8	
	RECITING				0	1				2		
READING COMPREHENSION	SYMBOL DISCRIMINATION	0	2	5	7	8	9		10			
	WORD RECOGNITION	0	1	3	4	5	6	7		8		
	COMPREHENSION OF ORAL SPELLING				0	1		3	4	6	7	8
	WORD-PICTURE MATCHING		0	1	4	6	8	9		10		
	READING SENTENCES AND PARAGRAPHS		0	1	2	3	4	5	6	7	8	10
WRITING	MECHANICS	1		2		3		4			5	
	SERIAL WRITING		0	7	18	25	30	35 X	40	43	46	47
	PRIMER-LEVEL DICTATION		0	1	4	6	9	11	13	14	15	
	SPELLING TO DICTATION					0	1	2	3	5	7	10
	WRITTEN CONFRONTATION NAMING				0	1	2	3	6	7	9	10
	SENTENCES TO DICTATION						0	X	3	6	8	12
	NARRATIVE WRITING		0	1			2			3	4	5
MUSIC	SINGING		0	1		2						
	RHYTHM		0	1				2				
SPATIAL AND COMPUTATIONAL	DRAWING TO COMMAND	0	6	7	8	9	10	11	12		13	
	STICK MEMORY	0	3	4	6	7	8	9	10	11	13	14
	3-D BLOCKS		0	2	4	5	6	7	8	9	10	
	TOTAL FINGERS	0	54	70	81	93	100	108	120	130	141	152
	RIGHT-LEFT	0	1	3	4	6	8	9	11	14	16	
	MAP ORIENTATION	0	2	5	6	9	11	13		14		
	ARITHMETIC		0	2	4	8	11	14	17	21	27	32
	CLOCK SETTING	0	3	4	6		8	9	10	12		
		0	10	20	30	40	50	60	70	80	90	100

Z-SCORE PROFILE OF APHASIA SUBSCORES

NAME: CB

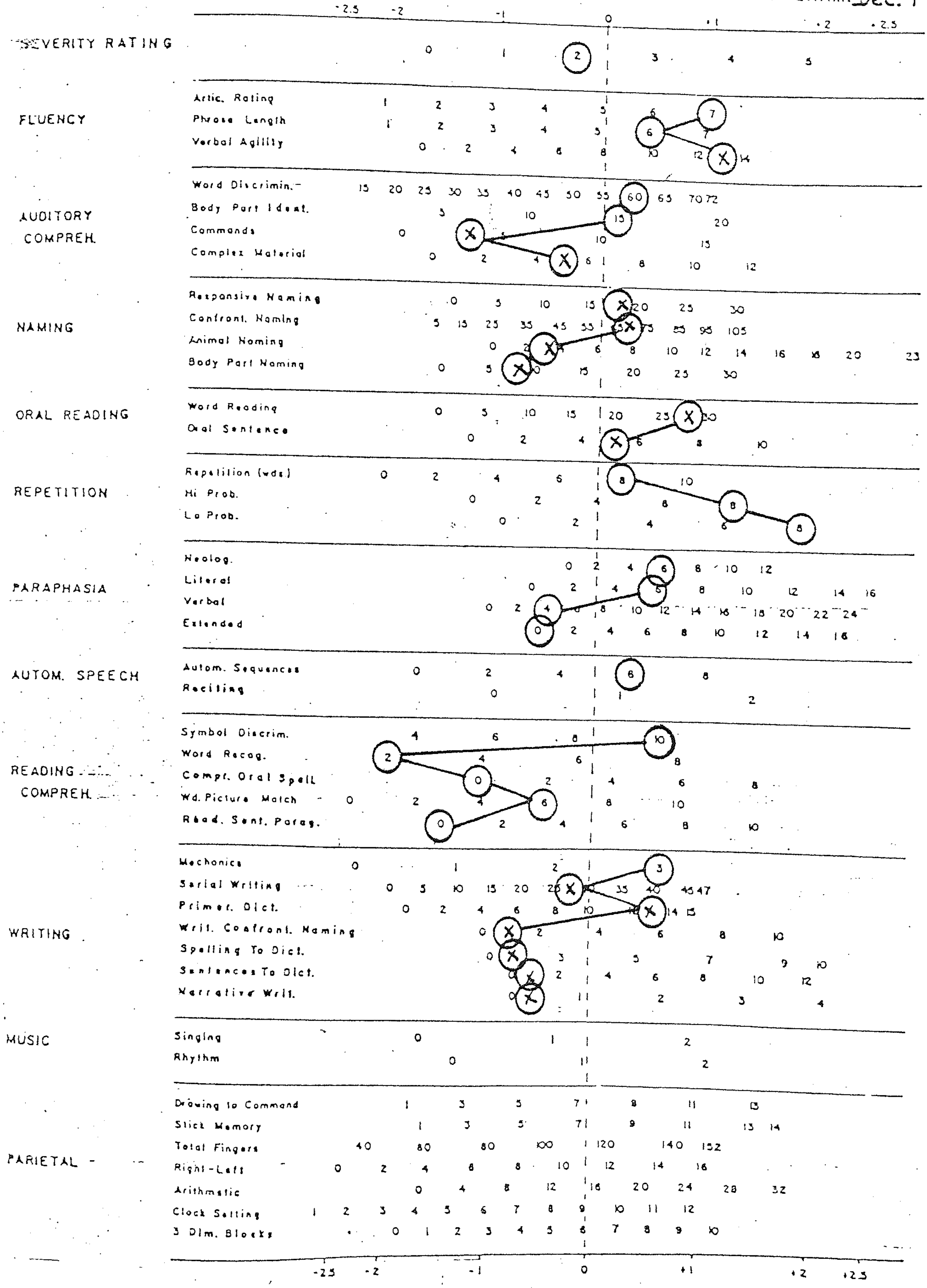
DATE OF EXAM: Feb. 1984



Z-SCORE PROFILE OF APHASIA SUBSCORES

NAME: JS

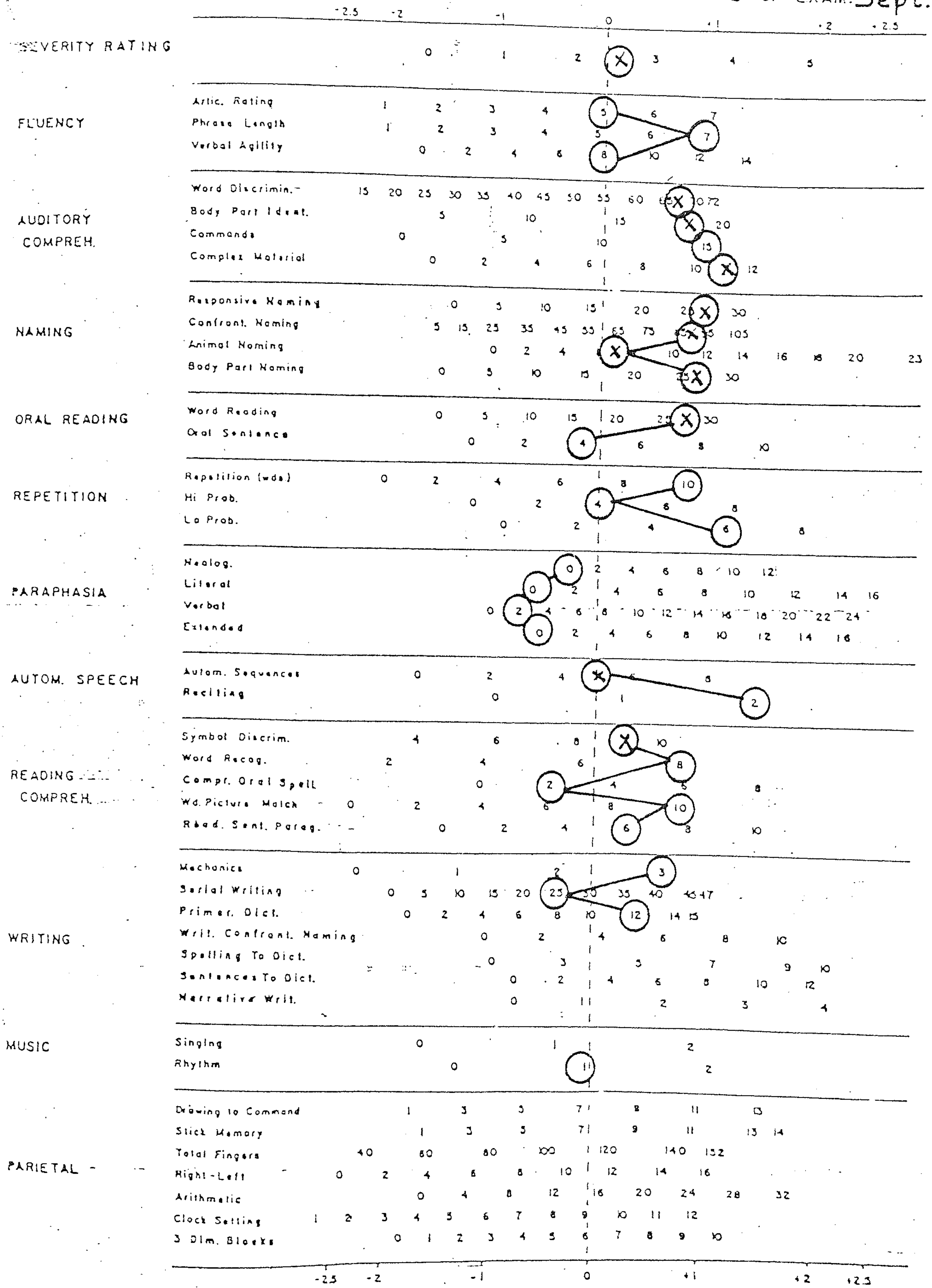
DATE OF EXAM: Dec. 1983



Z-SCORE PROFILE OF APHASIA SUBSCORES

NAME: ZS

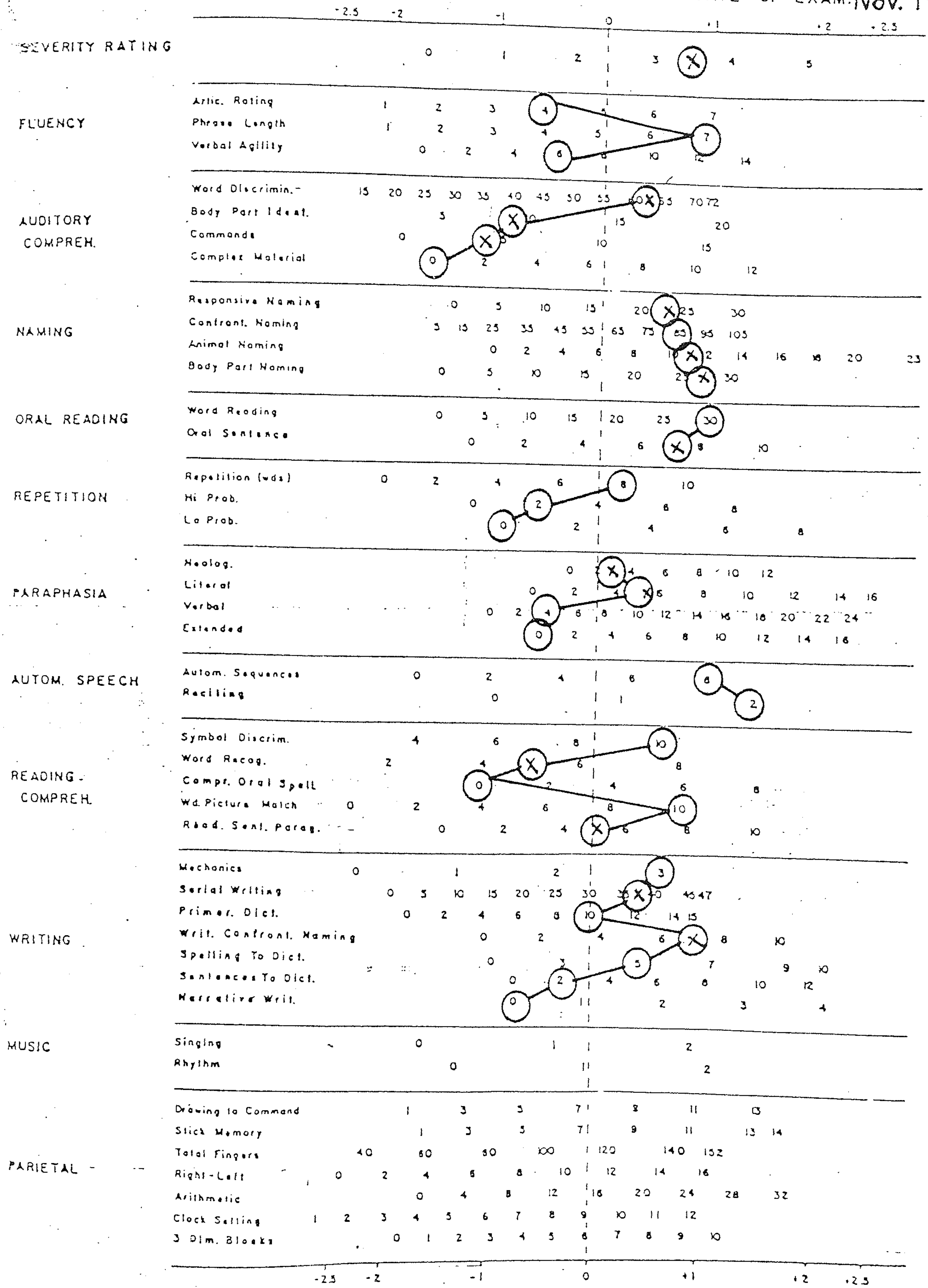
DATE OF EXAM: Sept. 198



Z-SCORE PROFILE OF APHASIA SUBSCORES

NAME: PG

DATE OF EXAM: Nov. 1983



SUBTEST SUMMARY PROFILE

NAME: FW

DATE OF EXAM: May 1985

PERCENTILES:		0	10	20	30	40	50	60	70	80	90	100
SEVERITY RATING			0	1				2		3	4	5
FLUENCY	ARTICULATION RATING		1	2	4	5	6	X	7			
	PHRASE LENGTH			1	3	4	5	[illegible]	7			
	MELODIC LINE		1	2	4		6	X				
	VERBAL AGILITY		0	2	5	6	8	9	1[illegible] X	13	14	
AUDITORY COMPREHENSION	WORD DISCRIMINATION	0	15	25	37	46	53	6[illegible] X	64	67	70	72
	BODY-PART IDENTIFICATION	0	1	5	10	11	15	X	17	18		20
	COMMANDS	0	3	4	6	8	10	11	13	14	15	
	COMPLEX IDEATIONAL MATERIAL		0	2	3	4	5	6	8	9	11	12
NAMING	RESPONSIVE NAMING			0	1	5	1[illegible] X	15	20	24	27	30
	CONFRONTATION NAMING		0	9	28	43	60	72	8[illegible] X	[illegible]4	105	114
	ANIMAL NAMING				0	1	2	3	4	6	9	23
ORAL READING	WORD READING			0	1	3	7	15	21 X	26	30	
	ORAL SENTENCE READING					0	1	2	4	7	9	10
REPETITION	REPETITION OF WORDS		0	2	5	7	8		9		10	
	HIGH-PROBABILITY			0	1		2	4	5	7	8	
	LOW-PROBABILITY					0	1		2	4	6	8
PARAPHASIA	NEOLOGISTIC	40	16	9	4	2	1		0			
	LITERAL	47	17	12	9	6	5	3		1	0	
	VERBAL	40	23	18	15	12	9	7	4	3	1	0
	EXTENDED	75	12	5	3	1	0					
AUTOMATIC SPEECH	AUTOMATIZED SEQUENCES		0	1	2	3	4	6	7		8	
	RECITING				0	1				2		
READING COMPREHENSION	SYMBOL DISCRIMINATION	0	2	5	7	8	9		10			
	WORD RECOGNITION	0	1	3	4	5	6	7		8		
	COMPREHENSION OF ORAL SPELLING				0			3	4	6	7	8
	WORD-PICTURE MATCHING		0	1	4	6	8	9		10		
	READING SENTENCES AND PARAGRAPHS		0	1	2	3	4	5	6	7	8 X	10
WRITING	MECHANICS	1		2		3		4			5	
	SERIAL WRITING		0	7	18	25	30	33	40	43	46	47
	PRIMER-LEVEL DICTATION		0	1	4	6	9	11	13	14	15	
	SPELLING TO DICTATION					0	1	2	3	5	7	10
	WRITTEN CONFRONTATION NAMING				0	1	2	3	6	7	9	10
	SENTENCES TO DICTATION						0	1	3	6	8	12
	NARRATIVE WRITING		0	1			2	X		3	4	5
MUSIC	SINGING		0	1		2						
	RHYTHM		0	1				2				
SPATIAL AND COMPUTATIONAL	DRAWING TO COMMAND	0	6	7	8	9	10	11	12		13	
	STICK MEMORY	0	3	4	6	7	8	9	10	11	13	14
	3-D BLOCKS		0	2	4	5	6	7	8	9	10	
	TOTAL FINGERS	0	54	70	81	93	100	108	120	130	141	152
	RIGHT-LEFT	0	1	3	4	6	8	9	11	14	16	
	MAP ORIENTATION	0	2	5	6	9	11	13		14		
	ARITHMETIC		0	2	4	8	11	14	17	21	27	32
	CLOCK SETTING	0	3	4	6		8	9	10	12		
		0	10	20	30	40	50	60	70	80	90	100

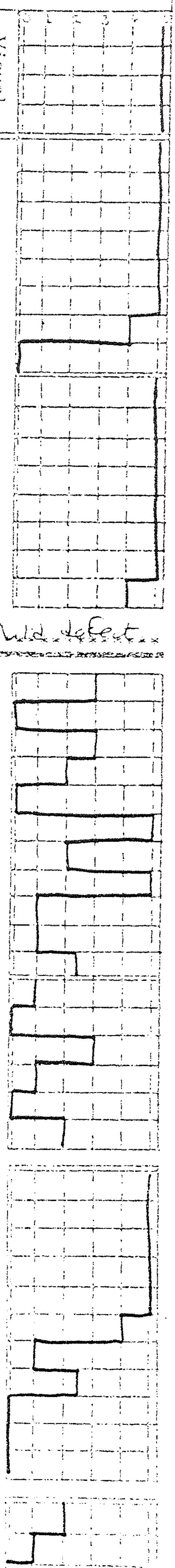
SUBTEST SUMMARY PROFILE

NAME: WPB

DATE OF EXAM: June 1984

PERCENTILES:		0	10	20	30	40	50	60	70	80	90	100
SEVERITY RATING			0	1				2		3	4	5
FLUENCY	ARTICULATION RATING		1	2	4	5	6		7			
	PHRASE LENGTH			1	3	4	5	6	7			
	MELODIC LINE		1	2	4		6	7				
	VERBAL AGILITY		0	2	5	6	8	[illegible]	11	13	14	
AUDITORY COMPREHENSION	WORD DISCRIMINATION	0	15	25	37	46	53	60	64	67	X	72
	BODY-PART IDENTIFICATION	0	1	5	10	13	15	16	17	18		20
	COMMANDS	0	3	4	6	8	10	11	13	14	15	
	COMPLEX IDEATIONAL MATERIAL		0	2	3	4	5	6	8	X	11	12
NAMING	RESPONSIVE NAMING			0	1	5	10	15	20	24	27	30
	CONFRONTATION NAMING		0	9	28	43	60	72	84	94	X	114
	ANIMAL NAMING				0	1	2	3	4	6	9	X 23
ORAL READING	WORD READING			0	1	3	7	15	21	26	30	
	ORAL SENTENCE READING					0	1	2	4	X	9	10
REPETITION	REPETITION OF WORDS		0	2	5	7	8		9		10	
	HIGH-PROBABILITY			0	1		2	4	5	7	8	
	LOW-PROBABILITY					0	1		2	4	[illegible]	X 8
PARAPHASIA	NEOLOGISTIC	40	16	9	4	2	1		0			
	LITERAL	47	17	12	9	6	5	3	2	1	0	
	VERBAL	40	23	18	15	12	9	7	4	3	1	0
	EXTENDED	75	12	5	3	1	0					
AUTOMATIC SPEECH	AUTOMATIZED SEQUENCES		0	1	2	3	4	6	7		8	
	RECITING				0	1				2		
READING COMPREHENSION	SYMBOL DISCRIMINATION	0	2	5	7	8	9		10			
	WORD RECOGNITION	0	1	3	4	5	6	7		8		
	COMPREHENSION OF ORAL SPELLING				0	1	X	[illegible]	4	[illegible]	7	8
	WORD-PICTURE MATCHING		0	1	4	6	8	9		10		
	READING SENTENCES AND PARAGRAPHS		0	1	2	3	4	5	6	7	8	10
WRITING	MECHANICS	1		2		3		4			5	
	SERIAL WRITING		0	7	18	25	30	33	40	43	X	47
	PRIMER-LEVEL DICTATION		0	1	4	6	9	11	13	14	15	
	SPELLING TO DICTATION					0	1	2	[illegible]	5	7	10
	WRITTEN CONFRONTATION NAMING				0	1	2	3	6	7	9	10
	SENTENCES TO DICTATION						0	1	3	6	8	12
	NARRATIVE WRITING		0	1			2			3	4	5
MUSIC	SINGING		0	1		2						
	RHYTHM		0	1				2				
SPATIAL AND COMPUTATIONAL	DRAWING TO COMMAND	0	6	7	8	9	10	11	12		13	
	STICK MEMORY	0	3	4	6	7	8	9	10	11	13	14
	3-D BLOCKS		0	2	4	5	6	7	8	9	10	
	TOTAL FINGERS	0	54	70	81	93	100	108	120	130	141	152
	RIGHT-LEFT	0	1	3	4	6	8	9	11	14	16	
	MAP ORIENTATION	0	2	5	6	9	11	13		14		
	ARITHMETIC		0	2	4	8	11	14	17	21	27	32
	CLOCK SETTING	0	3	4	6		8	9	10	12		
		0	10	20	30	40	50	60	70	80	90	100

Section	Item	Score	Defects
Pre-Test	A1 MATCHING Pictures	5	Visual Defects
	A2 MATCHING Colours	5	
	A3 MATCHING Shapes	5	
	A4 MATCHING Objects to Pictures	5	
Receptive Function (Input)	A5 MATCHING Numbers	5	Reading Defects
	A6 MATCHING Letters	5	
	A7 MATCHING Words	5	
	A8 MATCHING Sentences	5	
	A9 MATCHING Written Words to Pictures	5	
	A10 MATCHING Written Sentences to Pictures	5	
	A11 CARRYING OUT Simple Written Commands	5	
	A12 CARRYING OUT Complex Written Commands	4	
		0	
	A13 SELECTING TO AUDITORY COMMAND Pictures	5	Auditory Language Defects
	A14 SELECTING TO AUDITORY COMMAND Colours	5	
	A15 SELECTING TO AUDITORY COMMAND Numbers	5	
	A16 SELECTING TO AUDITORY COMMAND Letters	5	
	A17 SELECTING TO AUDITORY COMMAND Words	5	
	A18 SELECTING TO AUDITORY COMMAND Sentences	5	
	A19 CARRYING OUT Simple Oral Commands	5	
	A20 CARRYING OUT Complex Oral Commands	4	
	Receptive Total (Max. Correct Score — 100)	93	Mild defect
Expressive Function (Output)	B1 REPEATING Sounds	3	Speech Defects
	B2 REPEATING Groups of Sounds	0	
	B3 REPEATING Words	3	
	B4 REPEATING Sentences	2	
	B5 REPEATING SEQUENCES The Alphabet	0	
	B6 REPEATING SEQUENCES Days of the Week	5	
	B7 REPEATING SEQUENCES Months of the Year	2	
	B8 REPEATING SEQUENCES 1 — 20	5	
	B9 READING ALOUD Letters	1	
	B10 READING ALOUD Words	1	
	B11 READING ALOUD Sentences	2.5	
	B12 NAMING Objects	1	Language Defects
	B13 NAMING Colours	0	
	B14 NAMING Parts of the Body	3	
	B15 ORAL DESCRIPTION Use of Objects	1	
	B16 ORAL DESCRIPTION Action Pictures	0	
	B17 ORAL DESCRIPTION Composite Picture	2	
	B18 COPYING Letters	5	Writing Defects
	B19 COPYING Words	5	
	B20 COPYING Sentences	5	
	B21 WRITING TO DICTATION Numbers	5	
	B22 WRITING TO DICTATION Letters	5	
	B23 WRITING TO DICTATION Words	4	
	B24 WRITING TO DICTATION Sentence	1	
	B25 WRITING Names of Objects	2.5	
	B26 WRITTEN DESCRIPTION Use of Objects	0	
	B27 WRITTEN DESCRIPTION Action Pictures	0	
	B28 WRITTEN DESCRIPTION Composite Picture	0	
	B29 CALCULATION Written	2	Calcu[illegible]
	B30 CALCULATION Oral	1	



APPENDIX II

TRANSCRIPTS OF PATIENTS' READING OF THE PASSAGE OF TEXT

APPENDIX II

Transcripts of the patients' reading of the passage of text

The passage presented for reading aloud is described in Chapter 3, Section 3.1.2.3, and is reproduced below.

A Weekend Visit

Bob and Mary came to stay for a weekend.
We went to meet them by car.
We were rather late arriving at the station and
had to run up the steps to the platform.
The train had already arrived.
Bob waved to us through the crowd.
We showed them round the town.
We visited the shops.
They bought souvenirs.
Mary got a silver ashtray.
Bob chose a pen.
Then we all drove home.
Bob and Mary admired our new house.
They liked their bedroom which looked
out over the garden.

The next day was Sunday.
We saw the cathedral and the ruined castle.
The weather was fine.
We enjoyed ourselves.
They left in the evening.
They thanked us and asked us to visit them soon.

Bracketed items in quotation marks were given by the examiner when patients were unable or unwilling to proceed without responding to the item. Error responses corrected immediately are not counted as errors for the purpose of analysis of responses in text reading.

DA (Case Report I) Reading Text

Bob and Mary had, no ("came") to .... with the .... ("weekend"). We went to the .... ("meet") the .... car. We went .... better, no arriving at the trains and .... ("had") then why, no, and no, up and, we steps and, no, on, no ...., ... ("platform"). And, on train .... ("had") at arrived. Bob arrived, no to the .... ("through") the .... . We ate, no, him ride, no the town. And visited and shows. We, no, were .... ("souvenirs"). Mary got up silver ashtray. And, no, men .... ("chose") .... pen. The, the, we went, home. Bob and Mary .... ("admired") house, no, new house. .... took, no, our bedroom in, no, over, no look on over the garden. The next day we sunset, no Sunday. We /sə/, /sə/, the .... and the ground no ("ruined") ruins of ..... We weather were lovely. The ...., ... He were, no, on the night. ...., ... us on, no ..... him, no she visit her, him .....

DP (Case Report II) Reading Text

Bob and Mary came to stay for a weekend. One went up to meet some by car. We should rather late arrival and stand the station and buy /bʌn/ running to run in the steps. I should perform. I /'rujəl/ and already I'm arrive and Bob saved us to forget the crown. People .... we shower some around the town. We visit our shops. The /bə/ ..... I've got silver ashtrays. Bob wouldn't have spent. The we all drove home. Bob and Mary inspire our new house. They liked their bedroom which looked so our on the garden .... ("The") next day I Sunday. We .... ("saw") the chapel and .... ("the") ruined castle. The weather saw fine. We enjoyed .... ourselves. The left in .... the evening. The thanked us and asked to our visit them soon.

TW (Case Report III) Reading Text

Bob and Mary came to stay why .... for a weekend. We went to meet them by car. We were rather late arriving at no, the station and we had run then up steps to the /fə/ .... /fə/. Their train arrived early. Bob waved them up through the crowds. Their .... we showed them around the town. She visit the shops. And bought some souvenirs. Mary had a silver ashtray. Bob choose a pen. And we all drove home. Bob and Mary admired their new house. We like their bedroom and which looked up out of garden. The next time, no, day was Sunday. We saw the cathedral and we ruins, no the ruins castle. The weather was sunny. We enjoyed ourselves. We left them in the evening. When thanks us up we asked them to visit more often.

CB (Case Report IV) Reading Text

Bob and Mary came to stay for a weekend. He, we went to meet them by car. We .... were rather and /ə'raɪvə/, /ə'raɪvəns/, arriving at the station and had to rub, run up the steps to the platform. The train had arrived, already arrived. Bob waved to me throng, no .... the crowd. We showed them around the /tin/, town. We visit the shops. They bought souvenir. Mary got a silver ashtray. Bob chose a pen. Then we all drive home. Bob and Mary admired .... our new house. They liked .... their bedroom which looked out over the garden. The .... next day was Sunday .... We .... saw the cathedral and the ruin castle. The weather has fine. .... We enjoyed it ourselves. They left in the evening. They thanked .... and .... asked us to visit them soon.

JS (Case Report V) Reading Text

Bob and Mary /seɩm/ to stay for a weekend.

We went to meet them by car.

We were /rɑsə/ late arriving at the station and had to run up the steps /u/ the platform.

The train had already arrived.

/gɒb/ /beɩv/ to us through the crowd.

We showed them round the town.

We visited the shops.

They bought /'uvənɩəz/.

Mary got a silver ashtray.

Bob chose a /bɛn/.

Then we all drove home.

Bob and Mary admired our /lu/ house.

They liked their /wɛdrum/ which looked out over the garden.

The next day was Sunday.

We saw the cathedral and the ruined castle.

The weather was fine.

We enjoyed ourselves.

They left in the evening.

They thanked us all and asked us to visit them soon.

ZS (Case Report VI) Reading Text

Bob and Mary came to stay for a weekend. We went to meet them by car. We very rather late arriving at the station where had to run on the stairs to the platform. The train had already arrived. Bob waved to /ɷns/ through the crowd. We /ʃoɷ - ɛd/, showed them round town. We visited the shops. They brought sovereigns. Mary got a silver ashtray. Bob chosen a pen. Then we all drove home. Bob and Mary arrived our new house. They liked it bedroom which looked like over the garden. The next day very Sunday. We saw the cathedral and the ruined castle. The weather was fine. We enjoy ourselves. They left in the evening. They thanked us for asked we to do a visit to them soon.

PG (Case Report VII) Reading Text

Bob and Mary came to stay for a weekend. We went to meet them by car. We were rather late arriving at the station and had to run up the steps to the /pɑθfɔm/, /pætfɜm/. The train had always, already arrived. Bob waved to us .... through the crowd. We showed them round the town. We visited the shops. Then bought /suvrɛnz/. Mary got a silver ashtray. Bob chose a pen. Then we all drive home. Bob and Mary admired our new house. They liked their bedroom which looked out over the gardener. The next day we Saturday, no Sunday. We saw the cathedral and the ruined castle. The weather was fine. We enjoyed ourselves. Then left in the evening. They thanked so, as .... as asked us to visit them soon.

FW (Case Report VIII) Reading Text

Bob and Mary came to stay but a weekend. We were to meet them by car. We were rather late arrives, arrived at the station and .... had to .... run .... up .... the .... steps .... to ..... the .... platform. The train had already arrived. Bob came to us through the crowd. We showed them around the town. We visited the shops. We bought souvenirs. Mary got a silver ashtray. Bob choose a pen. Then we all rode home. Mary and Bob enquired our new house. They liked their bedroom which looked out over the garden. The next day was Sunday. We saw the cathedral and the ruins, ruined castle. The weather was fine. We enjoyed ourselves. They left on .... in the evening. They thanked us and asked us to visit them soon.

WPB (Case Report IX) Reading Text

Mary and Marie came to stay for a weekend. We had, we went to meet them by car. We were rather late arriving at the station and had to run up the steps to meet platforms. The train arrived early. Bob waved to us through the crowded, the crowd. We showed them round the town. We visited the shops. They had brought souvenirs. Mary got out a silver ashtray and Bob chose a pen. Then they were driven home. Bob and Mary admired our house tremendous - that's a funny way of putting it - Bob and Mary admired our house tremendous. They liked their bedroom which looked out over the garden. The next may, may was Sunday. We saw the cathedral and the ruined castle. The weather was fairly fine. We engaged ourselves, we enjoyed ourselves. They left in the evening. They thanked us and asked us to visit them soon.

IC (Case Report X) Reading Text

/bɒd/ and Mary come to stay for a weekend. We went to the /'munoɷ/ them by car. We went /bɜt/ late arriving on the /'sətə də .... də .... də dʌn ə tə sɛp ɒd ɑ fɑ - fɑ. tən də drənə ... bɒd fəd .. frə./ We /oɷd/ them /æd/ the shade. /'vədə/ the shop. They sob .... Mary got a /'seɩlvəd/ ashtray. Bob /pædʒ/ a /bən/. Then we /sɔl dɜd ʌm/.

Passage not completed.

APPENDIX III

ERROR CORPORA

DA

Reading Errors: Words

Visual

Sharing initial letter(s) with stimulus

Stimulus	Response
reminder	reading
journal	journeys
pint	pan
slate	splat
shrug	short
flood	flat
check	chicken
been	behave, no
began	behave, no
soul	sold
seem	see, see, no
behind	belong, no
tempest	temper
bait	bake
cab	cad
wink	wit, no

Sharing initial and final letter(s) with stimulus

pray	play, no
first	fist (2)
for	four ("one, two, three, four")
what	want
wanting	waiting
peal	pearl
plan	plain
sew	saw, no (sewing)

Sharing final letter(s) with stimulus

board	aboard
sham	ham
gold	old

Sharing letter(s) not in corresponding positions

want	and, no
root	shoots

Visual or semantic

cigar	cigarette
sword	saw
western	west

DA

Visual then semantic

Stimulus	Response	
county	houses	(country houses?)

Derivational (all visually similar)

aunt	auntie	N→N (diminutive)
build	buildings	V→N
deep	deeps	A→N
luck	lucky	N→A
drunken	(drunk it), drunk	A→A/V

Derivational or Inflectional (involving "ing")

laugh	laughing
dance	dancing
ask	asking
happen	happening
speak	speaking
sew	(saw), no, sewing

N = Noun
V = Verb
A = Adjective

Inflectional (all visually similar)

Nouns - singular and plural forms, regular plural formation
singular - plural

book	books (2)
apple	apples
steak	steaks
grill	grills
horse	horses
lip	lips (2)
egg	eggs
eye	eyes (2)
shoe	shoes (2)
dream	dreams
doctor	doctors (2)
stone	stones
plane	planes
shoe	shoes
boil	boils (could be verbal error)
snail	snails
seed	seeds
moth	moths
house	houses
door	doors

DA

Plural - Singular

Stimulus	Response
cats	cat
teachers	teacher
tables	table

Nouns - singular and plural forms, irregular plural formation

singular - plural

tooth	teeth
child	children

Verbs - past and present forms, regular past formation

arrive	arrived	present → past
prayed	pray	past → present

Verbs - past and present forms, irregular past formation

kept	keep	past → present
go	gone	present → past

Adjuectives - comparative and superlative forms

sweeter	sweet
hotter	hot
thinnest	thin
nicest	nice
strongest	strong

Function word substitutions

Visually similar

in	on
and	an
upon	up, no
his	he
them	him
hers	she (2)
herself	she
has	he
he	she
who	we

DA

Visually dissimilar

Stimulus	Response
if	on, no
is	he, no
	she, no
me	him
you	she
above	under
below	under
below	under,
	up,
	down

Semantic errors

Errors are subdivided into associative and shared feature errors. Note, however, that this distinction is, in many cases, difficult to make as most errors are related to the stimuli in both ways (see case report for discussion).

Associative

oxygen	hospital	
mortgage	house	
duel	shoot	
table	chair	
born	baby, no	
battle	fighting	
see	eye, no	
break	crocks	
travel	coach,	
	train	
dark	night (2)	
dove	fly	
hammer	tap	
sky	the sun, no	(addition of definite article)
deeper	down	
coats	coathanger	
steep	up	
mat	bath	
comb	hair	
lamp	(gaslight), gas	
farm	horse	
sign	street	
bright	light	
water	tea, no	

Associative (originating in the association of words within a common phrase. See also completion errors.

	mile	hour	(miles per hour)
C	hot	up, no	(hot up)
	beside	sit, no	(sit beside)
	help	call, no	(call for help)
	outside	shut, no	(shut outside)
	cruel	children, no	(cruelty to children)

Shared feature (superordinate)

student	children
glove	clothes
fresh	nice
fresh	nice, no
flower	garden
jet	plane
home	house
branch	trees
toad	animals (frog, no)

Shared feature (subordinate)

person	children
mouth	lip
lamp	gaslight (gas, no)
room	hall, no

Shared feature (coordinate)

	yacht	boat
	pony	horse
	woman	man, no
	fifty	four
	warm	hot (2)
	husband	mother, no
	brother	sister
	young	old
	lamp	light
	lemonade	orange (? orange short for "orangeade")
	south	north east
	husband	son
	brothers	sister
	seal	sealions
	pen	pencil
	cod	haddock
	lane	road, no
		street
C	thin	fat, no
	pint	pound

DA

Shared feature (coordinate)

Stimulus	Response
dress	skirt
woman	children, no
	man, no
woman	man
river	sea
C boy	girl
toad	(animals), frog, no
road	street
table	chair

Other error categories

Perseverative

amount	mind
garden	children
castle	house, no

Possibly visual, but not satisfying strict criteria

soul	saw
treat	salt
moment	minded
lad	leg
average	engine
peek	pit
street	school

Completion

good	be good
on	on top
C on	on top
drunken	drunk it, (drunk)

Phonemic paraphasias

youngest	/dʒʌŋ/
pant	/pæŋk/

Correct responses rejected (scored as correct)

big	big, no
but	but, no

DA

Omissions

fact
reason
method
truth
attitude
promise
origin
folly
topic
hint
event
excuse
democracy
office
gift
angle
musician
landscape
gauge
break
debt
come
shore
lose
move
prove
gone
gross
bury
borough
thorough
gang
should
attempt
support
explain
measure
control
near
single
narrow
double
natural
various
English
if
them
along

cult
pine
base
distress
take
turn
save
sort
capsule
splendid
scarce
sure
trough
soul
circuit
subtle
broad
strewn
spear
barge (meaning given)
throng
plug
protein
stupid
rub
battle (meaning given)
number
husband
love
follow
beat
want
agreement
chance
irony
hopelessness
ridicule
consent
sarcasm
camp
cost
amount
storm
machine
village
opinion
keg
ink

has
bring
enjoy
wonder
happen
do
found
able
narrow
south
due (2)
young
natural
bright
against
along
you
myself
whose
oil
hand
value
thing
number
health
problem
thought
am
do
been
shall
honour
cab
lad
rust
stud
plot
blunt
sprig
shock
tavern
sullen
butler
length
custom
blister
monster
loyalty

Omissions (continued)

their
beside
around
itself
though
without
between
anybody
tool
story
grave
shovel
throng
ocean
despair
mockery
hollow
thrift
timber
burden
duchess
correct
capsule
partner
factory
tapestry
stubborn
ministry
industry
attitude
low
warm
shore
problem
come
bring
help
arrive
happen
follow
beat
support
explain
richer
greatest
days
numbers
things
take

mast
lump
harp
dell
belief
plank
quest
barrel
beggar
bandit
monarch
profile
lobster
edition
tag
sly
loved
pressed
enjoyed
travelled
wondering
attempting
controlling
breaking
deed
reap
leak
tan
dab
rod
peat
load
loam
weapon
audit
weal
duel
poem
museum
oasis
fluid
ruin
duet
hive
tape
haze
hate
lake
zoo

torture
bulletin
splendid
distress
bug
sad
rut
tin
log
tact
sane
rock
crest
stunt
pluck
gallon
safe
wane
tap
tab
log
sag
hunt
dram
brat
trap
grab
belt
grit
debt
folk
knot
hymn
damn
writ
grin
fund
tint
sped
cask
lake
wound
family
bid
king
past
pick
pine
floor

DA

Reading Errors: Nonwords

Lexicalisations

Visually similar word (according to criteria for defining visual errors)

sharing initial letter(s) with stimulus

Stimulus	Response
owt	owl, no
bon	bond
mun	mum
shum	she, no
shen	she, no
peaf	pen, no
tring	trip, no

sharing initial and final letter(s) with stimulus

oin	on
voe	vase, no

sharing final letter(s) with stimulus

walp	swap
thip	hip, no

sharing letter(s) not in corresponding positions

ush	she, no
esh	she, no

Visually similar

Word (not satisfying criteria for visual error classification)

sharing initial letter with stimulus

feep	fit, no
dod	Dorothy, no
fep	fish, no

Other

troad	/stə/, (Visual, then semantic, then articulatory? (!) - road - street, which cannot be articulated).

DA

Omissions: Nonwords

bem
cridge
doard
kun
parsy
cabe
plafe
gog
balt
piver
koe
squate
bife
dight
mome
haper
poom
nove
rame
tround
stape
cown
farl
clut
wun
uze
woz
wor
bie
hoo
fue
oan
emp
noo
oum
aum
ecj
ish
tood
lail
soam
dack
thut
poth
drap
trab
nold
obe
ane
ife

akt
doo
nue
kan
sed
ize
gue
fou
kie
hoz
ekt
bue
kag
sem
ont
hoo
ine
ume
aze
bope
brobe
cath
doop
brean
peam
ploon
poom
sust
sweal
taze
tife
troat
ead
oid
aob
eth
ath
osh
doad
maut
meap
fush
nath
dunt
bram
trat
trin
ibe
eme
ome

ave
bove
brove
coth
doot
breat
plood
pook
sost
sweak
tave
trind
tive
tad

nud
lal
mub
yed
som
mep

sab
ank
ipt
alb
elt
isp
uld
ont
ind
esk
eap
aif
eem
uth
ith
ick
naud
yeed
keak
shap
huck
hant
dand
yelt
afe
ine
ove
ede

DP

Reading Errors: Words

Visual

sharing initial letter(s) with stimulus

Stimulus	Response
pint	pine
fund	fun, no
moss	mousse
gauge	gang
shove	shovel
plan	plane
C(1) break	breakfast (2)
treat	teach
been	bent
shrug	should
throng	thorough
mast	mask
though	thought
connoisseur	con
	cone
vaccination	vacations
discretion	deceptions
bright	bring
sparse	spartan
slimy	slimcea
tact	tack
tomb	Tom
menace	men
irony	iron
falsehood	false
vestige	vest
deed	deep
reap	real, no
weal	weed
duet	duo
big	bid
thud	thug
dram	damn
grit	grin
lamb	lamp
write	(wit), write
youngest	(younger), youngster
opinion	onions
vestibule	vest (/vɛstɪtʃut/)

DP

Visual (continued)

sharing initial and final letter(s) with stimulus

Stimulus	Response
desert	dessert
implement	impatient
sped	spread
average	avengeance
crowd	crowned
wilderness	wildness
lose	loose
slate	state
detection	detention
	desertion
cough	coach
impotence	impudence
strewn	sewn
notion	nation
threat	theft
spear	smear
beside	bedside
board	broad
aptitude	attitude
hit	hint
fresh	fetch
flatterer	flattener
spilt	split
venison	version
sly	slimy
sky	sly
rut	rust
brat	bait
	bat
sprig	spring
shock	sock
writ	wit, (write)
numbers	numbness
gross	grass

sharing final letter(s) with stimulus

tint	hint
cask	desk
tale	stale, no
realm	elm
reproach	approach
tab	jab
hunt	shunt
low	know
near	hear (2)

DP

Visual (continued)

sharing final letter(s) with stimulus (continued)

	Stimulus	Response
	narrow	marrow
	touching	coughing
C	sickly	quickly
	preside	decide
	sad	bad
	throng	strong
C	amount	mount
	trough	rough
	trout	spout
	mile	smile
	harp	sharp
C	dove	love
	dell	bell
	quest	guest
	shore	ashore

sharing medial letter(s) with stimulus

clever	eleven

sharing letter(s) not in corresponding positions

scarce	car, no
circuit	quits, no
torrid	porridge

Visual or Semantic

cigar	cigarettes
move	shove
sullen	sulky
lemonade	Lucozade
stubborn	stupid

Derivational

journal	journalist	NI → NA
musician	music	NA → NI
gymnastics	gymnasium	N → N
loyalty	loyally	N → Adv.
donation	donate	N → V
ridicule	ridiculous	N → A
natural	nature	A → N
backward	backwards	A → Adv.
drunken	drunk	A → A/V/N
safely	safety	Adv. → N
sincerely	sincere	Adv. → A
lengthy	lengthening	A → V/N
deafen	deaf, (deafening)	V → A
awkwardness	awkwardest	N → Sup.A

DP

Derivational or Inflectional (ing)

Stimulus	Response
garden	gardening
travelled	travelling
doings	doing
deafen	(deaf) deafening
houses	housing

Inflectional

Nouns: singular to plural and plural to singular, plural formation with "s"

method	methods	S → P
student	students	S → P
glove	gloves	S → P
capsule	capsules	S → P
monarch	monarchs	S → P
deduction	deductions	S → P
flower	flowers	S → P
debt	debts	S → P
desk	desks	S → P
teachers	teacher	P → S
tables	table	P → S
coats	coat	P → S

Nouns: singular to plural, plural formation without "s"

woman	women	S → P

Verbs: Tense, regular past formation

seem	seemed	Pres. → Past
ruin	ruined	Pres. → Past
torture	tortured	Pres. → Past
prayed	pray	Past → Pres.

Verbs: Tense, irregular past formation

sew	sewn	Pres. → PP
kept	keep	Past. → Pres.
began	begin	Past → Pres.

Inflectional (continued)

Stimulus	Response	
Adjectives		
hotter	hot	Comp. A → A
youngest	younger (youngster)	Sup. A → Comp. A

Function word substitutions

Visually similar

Stimulus	Response
them	the
whose	those
hers	her
shall	all
who	whom
hers	herself
itself	herself
you	(one), do

Visually distinct

Stimulus	Response
am	and (in this case there is visual closeness, although strict criteria not met)

Other

Possibly visual, not satisfying criteria

Stimulus	Response
hollow	narrow
cab	tap
	tape
criterion	interference
profile	counterfoil
honour	announce
enjoyed	annoyance
grapple	drinkable

Completion

Stimulus	Response
cost	Lo-cost

Negation

Stimulus	Response
should	shouldn't

DP

Visual and segmentation

Stimulus	Response
increment	in cement

Phonemic paraphasias

cult	/kʌlp/

Blending/Segmentation

between	/bi - twin
controlling	/kɒntroʊl - lɪŋ/

Regularisation

subtle	/sʌb - təl/

Literation

camouflage	"c", "a", "m", "p"

Mixed

disparity	/bɪs - pati/

Substitution, addition or omission of word segments

origin	/'ɒrɪs/ no	
vestibule	(vest), /'vɛstɪtʃut/	
infirmary	/fɜ'meɪtəri/	
metropolis	/ɛmpi'oʊlioʊs/	
essence	/'ɛsi/	
emporium	/ɛm ɜr'eɪʃn/	
unreality	/ʌnbɪlivətɪz/	(with semantic component)
competence	/kɒn'sɛptəns/	
elaboration	/'ɛlɛmbɔnieɪʃn/	
impropriety	/ɪm'pɜsɪkjut/	
thinnest	/taɪmɪst/	
islander	/ɪn'tændə/	
decided	/dɪ'saɪdəboʊl/	
laudable	/θɔn'teɪboʊl/	

DP

Substitution, addition or omission of word segments

Stimulus	Response
hazardous	/æn'zooi/
capsule	/kæpsɩn/
audit	/ɔdɩskri/
oasis	/ooneɩsɩs/
clamber	/sæmdʒə/
jargon	/'dʒaɩn'stɩg/
anecdote	/'ændɩs/
adroit	/ændroot/
grotesque	/'soogigoo/
insipid	/ɩn'sprɩg/
circumspect	/θɜ'mɩstɩks/
manifest	/mænɩ'fɛstju/

Incomplete

sarcasm	/sə/, no
lubricant	/kænt/ "I know that one"
edition	/ɛd/, /ɛd/, no
fallacy	/fæl/...
ingratitude	in, in .... "I know it".

Unclassified

you	one, (do)
democracy	men "don't know"

Omissions

do	"It's the little ones I don't know"
natural	
exclusion	
mortgage	
lump	
blossom	
trace	
compassion	
peek	
dab	
shun	
fill	
grab	

Reading Errors: Nonwords

Lexicalisations

Visually similar to stimulus

sharing initial letter(s) with stimulus

Stimulus	Response
bife	beef
rame	ramp
farl	far
clut	cuff
woz	woe
bie	beer/bier
akt	ask
bon	bond
mun	mum
oin	oil
gat	gate
gan	game
gub	guy
gusten	gust
joll	jelly
jasten	just
cal	cold
candet	candle
com	come
codden	cod, (/kɒdɩt/)
cuck	cup
cendel	candle
semp	seem/seam
sendel	sandals
sint	sign
sinten	sign (sign it)
brobe	brother
brean	breathe
sweal	sweat
tring	tin
sost	soap
trind	tin
kreme	kim
madjuk	(/mæn-ʃɛl/), mandril
shool	soon
kade	kay
larnter	lantern
lish	lit
tood	too/to
soam	soap
meap	means

DP

sharing initial letter(s) with stimulus (continued)

Stimulus	Response
mub	mud
fush	fuss
thut	thud
shen	shed
poth	pod
hant	hand
bram	bran
alb	amble
voe	vow
oum	out
ine	ink
ane	and
ove	oven
ome	owed (owe)

sharing initial and final letter(s) with stimulus

walp	wallop
parsy	parsley "but anyone would put the "t", no "y" in"
plafe	plate
gog	dog
balt	bolt
mome	more
cown	crown
sed	seed
sem	seem
noo	noose
gonden	Gordon
gud	good
gep	gap
gid	grid
gind	grid
gye	glue
jat	jet
jez	jazz
cep	cap
cemp	camp
sep	sap
coth	cloth
tive	time
troad	thread
leiter	letter
bislit	biscuit
maut	mutt
dod	dud
shap	sharp (/'ʃadæp/)

DP

sharing initial and final letter(s) with stimulus

Stimulus	Response
shum	sum, (sumptious)
yelt	yet
ome	(owed), owe
cridge	partridge
doard	board "but it's not right"
kun	run
piver	river
squate	equate
haper	caper
poom	room "it would be"
nove	move
tround	around "it's got a "t" in front"
stape	cape
nue	due
kan	an, (oil)
kie	tie
galter	alter/altar
gynten	lantern
jep	pep
jid	hid
jisson	mission
jye	eye (pointed to eye when asked meaning)
cuzz	buzz
culden	children
cib	bib
harcy	diary
kal	all
kax	lax
koll	doll
kuzz	buzz
kuck	luck
aze	haze
bope	rope
peam	sperm
sust	dust
taze	haze
troat	groat
doot	boot
peaf	deaf
plood	blood
pook	book
tave	wave
lail	ail
nud	dud
dack	Jack
huck	duck
dunt	punt
dand	brand
ank	dank
ipt	pit
isp	sip
uld	old
ead	fad
ick	pick

DP

sharing medial letter(s) with stimulus

Stimulus	Response
hargy	large

sharing letters not in corresponding positions

jecken	speck
ploon	loop
drap	(dripped), rapped
trin	sing
elt	alter
esk	(depth), decks
ife	few
aif	fire
uth	the
ath	that
ish	she
ibe	("i","b") beat

Visually distinct

sharing initial letter(s) with stimulus

foo	few
bue	booze
gom	gun
gezz	gas
jun	jam
yeed	yacht
nath	("n", "a", "t", "h"), napped
shum	(sum), sumptions
drap	dripped, (rapped)
eck	eat

sharing final letter(s) with stimulus

kag	chug
lal	yell
ith	chipped

sharing letters not in corresponding positions

dight	tie
owt	we
hoz	whose
cym	him
esk	depth (decks)

DP

sharing phoneme(s) but not letters with stimulus

Stimulus	Response
ligh	eye (pointed to eye when asked meaning)

Incorrect Nonwords

Gross/multiple errors of grapheme-phoneme conversion

wun	/ʌm/
oan	/ɷ- mʌm/
julter	/dʒulɩt/
codden	(cod), /'kɒdɩt/
kandet	/kɩdən/
madjik	/mæn - ʃɛl/, (mandril)
louter	/leɩʃə/
krume	("k", "m", "l"), /kʌmbə/
lepwerd	("l", "a", "g",) /lɩŋ/
naud	/ʃun/
mep	/ɛpθ/
shap	(sharp) , /'ʃɑdæp/
trat	/'dəræm/
nold	/jɷl/
oid	/ɷg/
oab	/ɒg/

Failure of marking function of silent e

ume	/ʌm/
eme	/ɛm/
ede	/ɛd/

Phonemic realisation of silent e

ave	/ævə/

Addition of single grapheme/phoneme

inull	/ɩŋɷl/

Omission of single grapheme/phoneme

bem	/ɛm/
esh	/ɛs/, (/ɛsk/)

DP

Substitution of single grapheme/phoneme

Stimulus	Response
kaje	/keɩd/
thip	/jɩp/
eem	/ɛm/
esh	(/ɛs/), /ɛsk/

Letter identification

krume	"k", "m", "l", (/kʌmbə/)
lepwerd	"l", "a", "g" (/lɩŋ/)
yed	"y", "e", "d"
nath	"n", "a", "t", "h", (napped)
obe	"o", "b", "e"
ibe	"i", "b", (beat)

Perseveration

kan	(an), oil
ont	oil
fep	yacht
trab	bran

Complex lexicalisation

sinten	(sign), sign it
doop	do up
inuff	if you
madlik	mad ink
doad	/boɷd -ʌp/

Unclassified

cabe	crayberry
doo	am

Omissions

ekt
gecken
gisson
jom
jonden
jub
jind
hargy
jynten
cax
coll

DP

Omissions (continued)

cint
cinten
cylden
kodden
kulden
harsy
sym
sylden
poom
brove
breat
sweak
phool
feep
tad
ont
ind
aum
eth

TW

Reading errors: Words

Visual

sharing initial letter(s) with stimulus

	Stimulus	Response
	imperceptible	imprecisely, no
	presupposition	pressurizing, no
	prototypical	protocol
	municipality	multiplication, no
	pine	pint
C	throng	through
	them	time, no
		then
	impress	impasse
	diminish	dimensions
	luminous	limousine, no
	seem	seen
	attempt	attend
	due	do
	though	thought
	thinnest	things
	sparse	spares
	circumspect	circumcize
	condiment	condemned
	scythe	scratch
	bourgeois	burglar
C	counsel	consent
	reap	read, no
C	steep	(climb, no) streak
	loam	lamb
		loan
	duet	duel
	haze	hail, no
	wane	want, no (wave)
	sham	shame
	path	paint
	belt	bend (bent up)
	grit	grin

sharing initial and final letter(s) with stimulus

steak	streak
lose	loose
gross	grass
treat	threat
trough	tough
subtle	subtitle

sharing initial and final letter(s) with stimulus (continued)

	Stimulus	Response
	county	country
	fresh	flesh
	shall	small
	went	want
	natural	neutral
C	glimmer	glamour
	dismal	dismissal
	complacent	complaint
	plot	pilot
	sprig	spring
	sullen	sudden
	lump	lamp
	dell	dwell
	shall	shell
C	slightly	(tightening), slowly
	laudable	laughable
	crowded	coward
	straighten	strengthen
	venison	vision
		version
	anecdote	antidote
	insipid	inspired
	grapple	grape, (not apple)
	preside	pesticide
	clamber	climber
	detect	direct
	medallion	meditation
C	photograph	phonograph
	exclusion	extortion
	strippling	stripping
	grenadier	gender
	worsted	worsened
C	crowd	coward
	wilderness	windiness
	mockery	monkey
	impotence	importance
	hit	hint
C	seed	speed
	wane	(want, no) wave
	sped	speed

TW

sharing final letter(s) with stimulus

Stimulus		Response
	origin	virgin
C	hunt	tint
	rapture	capture
	utensil	pencil
	discern	concern
	haughty	naughty
C	herself	self
C	support	report
	lighten	tighten
	grapple	(grape), not apple
	deduction	introduction
	chronic	ironic
	advice	device
	rod	nod
C	bomb	tomb, no
	tint	hunt
	cask	desk, no
		ask

sharing medial letter(s) with stimulus

recapitulate	captures

sharing letters not in corresponding positions

	standardisation	misunderstanding
C	go	of, no
	lengthy	rent, (length)
	adroit	doing, no
	emporium	comparison, no
	increment	cremation, no

Derivational

	islander	island	NA → NI
	pianist	piano	NA → NI
	infirmary	infirmity	NI → NI
	memoir	memory	NI → NI
C	design	designer	NI → NA
	gymnastics	gymnastic	N → A
	unreality	unreal	N → A
	psychosis	psychotic	N → A
	valued	value	A → N
	prayed	prayer	V → N
	prove	proven	V → A
	wound	wounded	N → A

Derivational (continued)

Stimulus	Response	
C backward	backwards	A → Adv.
lengthy	(rent), length	A → N
humiliatingly	humility	Adv. → A

Including prefix error

sincerely	insincere	A → A

Error on prefix

unsophisticated	sophisticated	A → A
miscalculations	calculations	N → N

Derivational or Inflectional (ing)

misunderstand	musunderstanding
doings	doing
piercing	pierce

Inflectional

Nouns: singular/plural confusion (all regular pural formation)

S - P

biscuit	biscuits
lip	lips
problem	problems (2)
idea	ideas
cobblestone	cobblestones

P - S

teachers	teacher

Verbs: present - past (all regular past formation)

dismiss	dismissed
popularise	popularised
arrive	arrived (2)

Adjective

nicest	nice

TW

Function word substitution

Visually similar

Stimulus	Response
been	between, no
your	yours
beside	besides

Visually dissimilar

you	glossed "Oh, the little one is... "

Semantic

C steep	climb, no (streak)

Other

Completion

up	come up, no
anybody	anybody's

Possibly visual, not satisfying criteria

C slightly	tightening, (slowly)
competence	comparison, /kɒm'poʊzəns/

Partial regularisation

concerto	/kɒn'seɪtoʊ/

Phonemic paraphasis

categorically	/kætə'gɒrəli/
dissatisfactions	/dɪsfætɪ'fækʃənz/
topic	/tɒfɪk/
officiate	/ɒ'fisɪkeɪt/
venerate	/'reɪdəreɪt/
ask	hast
alcove	/æfkoʊv/
chronic	/ɒ'rɒnɪk/, (ironic((difficulty in articulating visual error)

TW

Complex Function Word Substitutions

Stimulus	Response
hitherto	/hɪətu/
howsoever	whatsoever
whither	which, no
	whichever
whosoever	whatsoever
whereby	whichever, no which - by
whereas	which, no
	which are
thereby	which,
	there - by
thereof	hereafter
thereupon	whereas
	whereupon
herein	her own
hereby	what, no
	by
herewith	which, no
	without
heretofore	whatsoever
	whichsoever
whereof	which of

Visual and Articulation

connoisseur	/kɒn'ʃuə/ glossed "It's a French word ... doorman" (via commissionaire)

Substitution, addition or omission of word segments

procrastination	/pænɪ'neɪʃn̩/
disorderliness	/dɪs'loʊnlɪnɛs/
dimension	/dɪs'mænʃn̩/
rehabilitate	/rɛtəreɪt/
western	/wɛstrɪŋ/
metropolis	/'mɛtroʊ skoʊp/
	/'mɛtroʊpɒl'arɪs/
disparity	/dɪs'preɪ/
inducement	/kɒn'vʌldʒəns/
	/ɪn'djusɪs mɛnts/
competence	(comparison) /kɒm'poʊzəns/
elaboration	/ɪmpɔ'teɪʃn̩/
impropriety	/ɪpraɪ'pærəti/

TW

Unclassified

debt	/dɛpɪd/
loneliness	/ə'loʊnlɪnɪs/
rock	lug
custom	look, no
belt	(bend) bent up

Omissions

inappropriateness
belligerently
existentialism
repudiating
disproportionately
linguistically
plausible
furious
vestibule
lubricant
criterion
discretion
tribute
boomerang
poultice
oasis

Reading errors: Nonwords

Lexicalisations

Visually similar to stimulus

sharing initial letters with stimulus

haper	happen
farl	(girl, no) far
woz	who
owt	owl, well it's not but
akt	ark
nue	nun
mun	mum, "well it's like mum, there's an 'e'"
foo	food, "with the 'd',"
hoz	hog
ine	ink
gat	gap
gub	gut
gusten	gust
gisson	gas, no
jun	jump
joll	jelly
jom	jump
jud	jug
jep	Japan, no
jecken	jerked
jye	jay
jid	jilt
candet	candle
coll	college
com	come
codden	cod, no
culden	cuddle
cep	cab
cendel	candle
cinten	centre
cym	come
cylden	colder
kandet	kite, no
sib	slip
sinten	sin
doot	door
leiter	lighten
ligh	lighten
biskit	bikini, well it's ...
louter	lout
kade	kid
lish	lie
laborcolator	laboratory

sharing initial letters with stimulus (continued)

Stimulus	Response
forgivunable	forgiving
cannistibalic	cannibalism
dimeocrities	discrimination
comormemating	communication
cirsemicular	circumcise
compatibinility	complaints, but no
tad	tab
lal	lad
mub	mud
elt	elf
ind	in (nude)
ath	an
ith	in
feep	(sleep), feet
keak	keep
thut	thud
shum	shun
shen	sheep "Well, it's not a sheep "
poth	(path), pot
hant	hand, no
drap	drab
dand	dam/damn
trat	trap
yelt	yield
trin	trip
afe	after

sharing initial and final letter(s) with stimulus

walp	wallop
cridge	cribbage
kun	(bun), kin
parsy	parsley
cabe	cabbage
plafe	plate
squate	square
dight	delight
poom	pom
stape	staple
cown	crown
clut	cut
bie	bite, but it's not
fue	flute
sed	sad
gue	glue

sharing initial and final letter(s) with stimulus

Stimulus	Response
kie	kite
bue	blue
kag	keg
sem	seem
gan	gun
jat	jet
jez	jazz
jisson	Jason
cal	call
cuck	cook
cemp	camp
sep	sup
sendel	sandal
sint	sent
cath	cloth
doop	droop
brean	bread
sweal	swell
tring	thing
troat	treat
coth	cloth
breat	beat
plood	plod
sweak	squeak
troad	told
kaje	kite
shool	school
larnter	ladder, but it's ...
lepwerd	leopard
habinitation	habitation
electrifationic	electronic
dod	dad
yed	yield
som	sum/some, but not ...
mep	map
sab	scab
oid	old
ick	ink
tood	told
yeed	yield
meap	map, no
dack	duck
fush	flush
shap	snap
poth	path (pot)

TW

sharing final letter(s) with stimulus

Stimulus	Response
doard	board
kun	bun, (kin)
balt	"like salt"
piver	river
koe	canoe
bife	knife
rame	name
tround	around
farl	girl, no (far)
wun	bun, well no
uze	doze
C kan	tan
galter	alter/altar
goll	doll
gezz	jazz
gye	eye/aye
gynten	lantern
jasten	fasten
jind	behind
cuzz	buzz
kuck	duck
kulden	garden
semp	limp
aze	daze
brobe	probe
sust	dust
taze	daze
tife	life
bove	dove
peaf	deaf
pook	book
sost	toast
trind	find
tive	live/laɪv/
inuff	muff
lepperd	peppered
inull	null
lumilinations	illuminations, glossed "Blackpool"
lucinhallations	hallucinations
faep	heap, no
ank	ink
ipt	apt
uld	old
ont	ant
esk	desk
emp	camp
ead	bead, no
eap	cap

TW

sharing final letter(s) with stimulus (continued)

Stimulus	Response
aif	if
aum	bum
eth	path
uth	truth
eck	neck
doad	broad
naud	Maud, but no
lail	nail
maut	ant
feep	sleep (feet)
huck	luck, well no
thip	hip
dunt	ant
bram	pram, well not really
trab	crab, well no
nold	gold, no
obe	be
ine	(nick, no) nine
eme	come
ede	wade, no
ome	come
ife	life

sharing letter(s) not in corresponding positions

oin	ink, well no
ont	iron
hargy	argue
kal	lack
phool	spook
ind	(in), nude
oab	boat
ibe	bead
ine	nick, no (nine)

Visually distinct

sharing initial letter(s) with stimulus

sym	smiling
bope	bat
poom	promenade
krume	kenner
bislit	business, well, no
exaggationers	excommunicate, no
osh	oat

sharing letter(s) not in corresponding positions

ekt	ink, but no, well nothing
ume	seem
eem	bead, no
ish	shore/sure
ane	con

sharing no letters or phonemes with stimulus

Stimulus	Response
ize	own
	gnome
gep	jack

Gross/Multiple errors of grapheme-phoneme conversion

nove	/fʊb/
gid	/gɪdəl/

Omission/misconversion of single grapheme/phoneme

isp	/ɪp/
oum	/ɔm/

Other

Segmentation

madjik	mad ink
madlik	mad ink

Unclassified

esh	it, "h"

Omissions

bem	
mome	
oan	"it's nothing, don't know"
gonden	
gud	
gecken	
gind	
julter	
jonden	
jub	
nath	"it's no word"
harjy	
jynten	
cax	

Omissions (continued)

cuzz
cib
cint
harcy
kax
koll
kom
kodden
harsy
sylden
incocidental
cenectricities
gracontulation
reostephonic
imparsonious
ramifationic
algenerities
logibiocally

C.B.

Reading Errors: Words

Sharing initial letter(s) with stimulus

Stimulus	Response
borough	brought
treat	tread
pine	pint
base	basin
flood	floor
strewn	shrewd
free	freeze (meaning demonstrated)
protein	project (N)
due	duel
compassion	compass
hatchet	hatch
diminish	dimension
concentric	consideration
horizontal	horizon
though	thought
acrobat	aerobic
medallion	medal
metropolis	metal, no
connoisseur	conscience, no
competence	company
keg	key, no (kə- ɛg)
profile	profit
cask	cash
shun	shunt
wane	wank
happen	happy, no
pressed	present
flatterer	fluttering
lengthy	lengthways
rust	rustle
partner	partition
flag	flat
presupposition	presumably
linguistically	list, no listing
vestige	vest
manifest	manifold

C.B.

Sharing initial and final letter(s) with stimulus

Stimulus	Response	
equity	equality	
simile	smile	
abyss	(ə'baɩjə), abscess	
gauge	gauze	
debt	debit (2)	
scarce	scare	
runway	runaway	
conceive	convenience	
pickle	prickle	
concerned	conceited	
placid	placed	
herein	heron	
horsehair	horsefair	
criterion	Crichton [glossed "The Admirable Crichton"]	
spilt	split, no	
anecdote	antidote	
sparse	spare	
impotence	importance	

Visual or Semantic

intellect	intelligent	
C cigar	cigarette	
impress	imprint	
disparity	discrepancy	
cleaning	cleansing	

Derivational

C idea	ideal	N → A
disorderliness	disorderly	N → A
industry	industrious	N → A
municipality	municipal	N → A
loneliness	lonely	N → A
gymnastics	gymnastic	N → A
unreality	unreal	N → A
loyalty	loyal	N → A
reality	real	N → A
ridicule	ridiculous	N → A
sarcasm	sarcastic	N → A
C opinion	opinionated	N → A
blister	blistered	N → A
pianist	piano	N (An.) → N (Inan.)
monarch	monarchy	N (An.) → N (Inan.)
edition	editor	N (Inan.) → N (An.)
C farm	farmer	N (Inan.) → N (An.)
suffrage	suffragette	N (Inan.) → N (An.)

C.B.

Derivational (continued)

	Stimulus	Response	
	detection	detective	N (Inan.) → N (An.)
	reminder	remind	N → V
C	aunt	auntie	N → N
	exclusion	excluding	N → V/N
	deep	deepen	A → V
	imperceptible	imperceptibility	A → N
	prototypical	prototype	A → N
	drunken	drunk	A → A/N/V
		drunkard	A → N
C	sane	sanity	A → N
	civilised	civilian	A → A/N
	English	England	A → N
	richer	riches	A → N
	hazardous	hazard	A → N
	slimy	slime	A → N
	valued	value, no	A/V → N
	popularise	population	V → N
C	discover	discovery	V → N
	rehabilitate	rehabilitation	V → N
	misunderstand	misunderstanding	V → N
	indulge	indulgence	V → N
	harmonise	harmony	V → N
	torture	tortured	N/V → A/V
	laugh	laughter	N/V → N
	humiliatingly	humiliate	Adv. → V

Derivational or Inflectional (ing)

	enjoyed	enjoying
	travelled	travelling
C	attempting	attempted
	slightly	slighting
	clamber	clambering, no
	shock	shocking
	cracked	cracking (/krækən/)
	crowded	(/kraʊdɪ/, no), crowding
	deafen	deafening
	harden	hardening
	decided	deciding
	wanting	wanted
	doings	doing

Derivational - Prefix alteration

impropriety	propriety

C.B.

Inflectional

Nouns: singular to plural and plural to singular, plural formation with "s"

Stimulus	Response	
C attitude	attitudes	S → P
C house	houses	S → P
mushroom	mushrooms	S → P
houses	house	P → S
miscalculations	miscalculation	P → S
confederations	confederation	P → S

Nouns: singular to plural and plural to singular, plural formation without "s"

child	children	S → P
emporium	emporia	S → P

Verbs. Tense, regular past formation

reap	reaped	Pres. → Past

Verbs. Tense, irregular past formation

kept	keep	Past → Pres.
spend	spent	Pres.→ Past

Adjectives

hotter	hot	Comp. A → A

Function word substitutions

Visually similar

howsoever	whosoever
whosoever	whomsoever
whereas	wherever
thereof	hereof
thereupon	hereupon
who	what
their	they
his	is
who	whose
whereof	here, no

Visually distinct

been	has

Semantic

lamp	light

C.B.

Other

Stimulus	Response
Possibly visual, not satisfying criteria	
drastic	degree
Completion	
thorough	thoroughfare
under	underpass
Blending	
discord	/dis - kɔd/
infirmary	/ɩn'fɜ- mɛəri/
increment	/ɩn - krə - mɛnt/
insipid	/ɩn - sɩp - ɩd/
keg	(key, no), /kə - ɛg/
whereby	/wɛə - ḃaɩ/
Regularisation	
burg	/bʌri/
islander	Icelander (partial regularisation)
Attempts to read via sub-lexical grapheme-phoneme conversion	
fallacy	(/fɒl/), /fɒl'ɒsi/
B shrug	/sə - rəg/, no
subtle	/sʌptɜli/

C.B.

Other (continued)

Substitution, addition or omission of word segments

Stimulus	Response
+ parsonage	/'pasəni/
+ dishearten	/dɩs'hɑtɩd/
+ venerate	/'vɛnɜrəl/
B complacent	/kɒm - plæsɩd/
B hereby	here - on - by, /hɛrənbi/
B heretofore	here-to-forest
∓ splendid	/splɛndənt/
+ B inappropriateness	/ɩn`æproɷeɩt - ɩvi/
∓ overconfident	/oɷvəkɒn'faɩd/
+ flatten	/flætɩŋ/
dissatisfaction	/dɩsɩn`fæktəri/
undemocratic	/ʌndɩmɒstɩdʒri/
B manifest	/maen -ɩ- foɷld/
abyss	/ə'bɑɩjə/, (abscess)
+ cracked	(cracking), /'krækən/
+ crowded	/krɑɷdi/, no, (crowding)
B whichever	with - ever

+ inappropriately affixed

Incomplete

fallacy	/fɒl/, (/fɒl'ɒsi/)
circumspect	/səčəm/
disproportionately	/dɩs/

Bizarre

standardisation	disciplinarian

Omissions

vaccination
elaboration
repudiating
placard

C.B.

Reading Errors: Nonwords

Lexicalisations - Visually similar to stimulus

Sharing initial letter(s) with stimulus

	Stimulus	Response
	doard	dote
*	piver	pivot, (/pɩvɩt/)
*	quate	squirt
*	bife	beef
*	rame	rum
*	cown	cowed
*	clut	cluck, (/klʌ - tə/)
*	fue	fuel
*		fend
*	doo	door
*	bon	bonk
*	mun	monk
*	bopr	bop
*	aze	as
*	breat	brief ("b", "r", "e", "a", "t"), (/beɩvrə/)
	madjik	mad, (/mæd - dʒɩk/)
	madlik	mad, (/ mæd - lɩk)
	lepwerd	ledger
*	yed	yet (/ji - bə/), (/ji - də/)
*	tood	(toad), too
*	doad	dote, no (dough)
	lail	laying, no (leɩlə/)
*	yelt	yelp
*	trin	trip
*	dup	dupe
	elb	Elbe (glossed "Island of Elbe")
C	ath	athletics
*	taud	taut
	yoam	yard
		job
*	shan	sham
	sheb	Sheba
C	blap	blank
*	blit	blink, no (/blɩk/)
*	trib	tribe
*	cal	cad, no (cadge)
*	cax	cack
*	com	come
*	cuzz	cues
	harcy	harsh (/rə - hæd - sə/), (/hæd - sɩm/)
	cylden	(cycle to), no cycle
	sylden	Sylvester, (den)
*	gat	gate
	jecken	Jekyll, no, glossed "Dr. Jekyll"
	laborcolator	laboratory, no
	forgivunable	forgiveness
	cannistibalic	cannibalistic
	dimeocrities	diamond, no
		demented, no
	comormemating	commentrary, no
	compatibinility	compatible

Lexicalisations - visually similar to stimulus (continued)

Sharing initial and final letter(s) with stimulus

	Stimulus	Response
	dight	digit, (digitalis)
	*parsy	parsley
	*cabe	cable
	*bue	blue
	*sweal	swirl
	*troat	trout
C	*coth	cloth
	*phool	pool
	larnter	lighter, no
	*bislit	biscuit, it sounds like, but no
	*som	sum
	*sab	scab
	*voe	vogue
	*tood	toad, (too)
	*maut	malt
	C feep	flip, (/fə - i - pə/)
	*nath	north
	*huck	hunk, no (/ʌnk/)
	*hant	hunt
	*tep	tap
		tip
C	*sim	slim
	*cuck	cook
	cint	can't
	cinten	can, (Kæn'dɛs), (canny)(candy)
	gep	gap
	jasten	Justin

Sharing final letter(s) with stimulus

	Stimulus	Response
	*tround	(/trut/), round
*	C ave	have
	*ank	tank
	*shap	bap, no
*	C shen	hen
*	C thip	hip
	trat	rat, (/tə - ræt/)
*	C nold	old
	eaf	deaf
	C ush	hush, glossed "Hush, sweet Charlotte"
	*peam	beam
	tron	roan
	sylden	(sylvester), den
	*yab	(/jæd/), gab

Lexicalisations - visually similar to stimulus (continued)

Sharing medial letter(s) with stimulus

Stimulus	Response
dand	gang, no (/dæ - ænd/)

Sharing letter(s) not in corresponding positions

jye	(/dʒi - ɩt/, yet
incocidental	coincidentally

Sharing initial letter(s) with stimulus

dight	(digit) digitalis
woz	woods, (/wəz/)
* wor	what
* akt	(æ - kə - tə/), actor
* noo	new
* doat	(dote), no, dough
* naud	nought
keak	keener
* cal	(cad) no, cadge
cinten	(can), (/kændɛs/) canny candy
C und	underpass

Sharing medial letter(s) with stimulus

* wun	ones
* C kag	can
ine	and
* C kom	come, no

Sharing letter(s) not in corresponding positions

oum	dome
rith	thick
* kax	can, /kænɩks/
C kandet	and
* koll	Skol glossed "it's lager"

C.B.

Incorrect nonwords

Mixed/multiple errors of grapheme-phoneme conversion

	Stimulus	Response
	piver	(pivot) /pɩvɩt/
	tround	/trut/, (round)
	oin	/ɒnk/
	peam	(/pif/)(/piv - mə/), /pivrə/
	taze	/læ'zɛl/, (/teɩzi/)
B	brove	/brə - ɒf/, (/broωf/)
	breat	(brief), ("b", "r", "e"s, "a", "t"), /beɩvrə/
	leiter	/lɑɩftən/
	louter	/lɛd - də/
	shool	/sum/
	krume	/kriməl/
B	lish	/lɩt - sə/ (/lɩ-sə -hə/)
B	yed	(yet), /ji - bə/, (/ji - də̄/)
	huck	(hunk) no, /ʌnk/
	ilt	/ɑɩθ/,
		/æ - lɑt/
	leam	/lɛ mp/
	plet	/plɩnk/
	yant	/jæmp/
	culden	/skʌldə/, (/skʌldən/)
	kuzz	/skɛt/,
C		/skʌl/
	kuck	/lʌks/ no /kælʌks/
	cinten	(can), /kæn'dɛs/, (canny) (candy)
B	harcy	(harsh), /tə - hæd - sə/
B		/hæd - sɩm/
B	gom	/goω - bə/, (/goω - mə/)
	gecken	/dʒə - gɛktən/
	gye	/giɒt/
	gynten	/'ɩnt gɩnt/
		/gɩntə/
		/gɩntɩd/
	julter	/'dʒəltɜreɩt/
	jonden	/'dʒɒnɛl/, (/dʒɒndɛnt/)
B	harjg	/hæd - dʒə - weɩ/
B	jye	/dʒi - ɩt/, (yet)
	jynten	/dʒeɩ - ɛnt/, no

Substitution, addition or omission of word segments

Stimulus	Response
exaggationers	/ɛk'zɒnɩfɑɩ/
lumilinations	/ɩ'lumɩnɩst/
habinitation	/hæb - i - ti - ɛ - trɩn/
cenectricities	/kɒn - si - ɛk -tɩk/
reostephonic	/ˌdoωsti'ɒfɒni/
lucinhallations	/lusihæleɩʃənz/
electrifationic	/ilɛk - tri - fæt - i in/
imparsonions	/'ɩmprɒpoʃənɩt/
cirsemicular	/'sɜ̄ksikələ/

C.B.

Incorrect nonwords (continued)

Phonemic realisation of silent e

Stimulus	Response
uze	/ʌzə/
taze	(/læ'zɛl/), /tezzi/
tive	/tɩvi/

Failure of marking function of final e

kade	/kæd/

Addition of Single Grapheme/Phoneme

	bem	/bɛmf/
	bie	/bɑ n/
	ekt	(/ɛ - kə - tə/),
B	peam	(/pif/), /piv - mə/, (/pivrə/)
E	ead	/iæd/
B	aif	/eɩjə - ɛf/, ("a", "i", /fə/)
B	oab	/oɷd - bə/
R/B	eap	/i-æ - pə/
B	aum	/eɩ - ʌpə/
B	ath	/e - θə/
	esh	/ɩʃ/
B	osh	/oɷ - ʃ/
	lail	(laying) no /leɩlə/
	shum	/ʃʌmbə/
	usp	/ɪnsp/
B	eck	/i - kə/
R	roid	toɩ - ɩdə
	kax	(can), /kænɩks/
	culden	(/skʌldə/), /skʌldən/
B	harsy	/had - si/
	hargy	/hagɩt/
C	jun	/dʒʌnt/
	jonden	(/'dʒɒnɛl/), /dʒɒndɛnt/

Omission of Single Grapheme-Phoneme

B	yeed	/i - də/
B	fush	/fə - ʃə/
	gonden	/gɒndə/
	gusten	/'gʌtən/

CB

Incorrect nonwords (continued)

Substitution of Single Grapheme/Phoneme

Stimulus		Response
C	kun	/kʌg/
	mome	/mɒmp/
	haper	/hæpəl/
	woz	/woods/, /wəɪ/
	peam	/pif/ (/piv - mə/), (/pivrə/)
	tife	/tif/
	brove	(/brə - ɒf/), /broof/
	troad	/traod/
	larfter	/læktə/
		/laɪftə/
B	yed	(yet), (/ji - bə/), /ji - də/
C	mep	/mi - pə/
B	ipt	/eɪ - pə - tə/
B	elt	/i - lə - tə/
B	isp	/ɪz - pə/
B	ont	/oo - nə - tə/
	esk	/ɪsk/
R/B	oid	/oo- ɪdə/
	dunt	/mʌnt/
	lup	/lʌm/
	yab	/jæd/, (gab)
	ent	/ɛnθ/ (to)
	ump	/ʌmb/, (/ʌm - pə/)
	onk	/ɔɪnk/
	blit	(blink) no /blɪk/
B	kodden	/kɒd - dɛt/
B	sinten	/sɪn - ti/, no
B		/sɪn - tɛl/, no
	gan	/dʒæn/
	gom	/goo - bə/ /goo - mə/
	gub	/gʌp/
	gud	/dʒʌd/
	gisson	/dʒɪsoo/
	jom	/gɒm/, no
	jisson	/dʒɪzən/

CB

Other

Blending

Stimulus	Response
walp	/wɒl - pə/
cridge	/krɩ - dʒə/
farl	/fa - əl/
clut	(cluck), /klʌ - tə/
oan	/oɷ - æn/
akt	/æ - kə - tə/, (actor)
ekt	/ɛ - kə - tə/, (/ɛktəl) preceded by "oh, no!"
sweak	/swi - kə/
madjik	(mad), /mæd - dʒɩk/
kaje	/keɩ - dʒə/
madlik	(mad), /mæd - lɩk/
lish	(/lɩt - sə/), /lɩ - sə - hə/
nud	/nju - də/
eem	/i - mə/
feep	(flip), /fə - i - pə/
dand	gang, nc /də - ænd/
trat	(rat), /tə - ræt/,
ump	(/ʌmp/), /ʌm - pə/
ood	/u - də/
oom	/u - mə/
oal	/oɷ - le/, ("o", "a", "l")
candet	/kæn - dɛtə/ glossed "Robert Redford in 'The Candidate'"
codden	/cɒd - dɛn/
sint	/sɩn - tə/

Letter identification

breat	(brief), "b", "r", "e", "a", "t", (/beɩvrə/)
aif	(/eɩjə - ɛf/), "a", "i", /fə/
oal	(/oɷ - lə/), "o", "a", "l"

Resegmentation

aup	/æ - ʌp/
meap	"just me and /æp/, /mi - æp/

Incomplete

thut	/θə/ and /tə/,
	/θə/ and /kə/
gezz	/gə/, "Z"
ramifationic	ram ....
algenerities	/aɩkə........../
logibiocally	/l ɒ g ..../, no

CB

Complex lexicalisation

Stimulus	Response
cylden	cycle to, no (cycle)

Unclassified

plafe	/pleɪt - fə/

Omissions

gracontulation

Note

* indicates that error could also result from the misconversion of a single grapheme.

R/B or B indicates a resegmentation/blending error in addition to the error on the basis of which response is categorised.

JS

Reading Errors: Words

Stimulus	Response	
Visual		
sharing initial letter(s) with stimulus		
imperceptible	impersonation	
hammer	home	
infirmary	information	
impotence	impatient	
sharing initial and final letter(s) with stimulus		
bowl	bowel	
spend	splendid	
anecdote	antidote	
runway	runaway	
audit	adult	
desert	dessert	
sharing final letter(s) with stimulus		
shall	call	
Derivational		
aunt	auntie	N → N
microscope	microscopic	N → A
ridicule	ridiculous	N → A
Derivational or Inflectional (ing)		
C gone	going	
dance	dancing	
doings	doing	
Inflectional		
promise	promises	
press	presses	
lip	lips	
Function word substitution		
C but	that	

JS

Phonemic paraphasias

Stimulus	Response
street	/srit/
school	/ʃul/
boy	/jɔɪ/
man	/næn/
child	/tʃɑʊld/
categorically	/ˈkɑrə gɒrɪkli/
disproportionately	/ dɪsəˈsɔʃʊnɪtli/
excuse	/ˈɛskjus/
student	/judənt/
journal	/ˈdʒnəl/
cigar	/zɪˈgɑ/
musician	/ˈduzɪʃn/
landscape	/ˈlænd seɪk/
steak	lake[a] ˈ
mortgage	/ lɔgɪdʒ/
glove	/ˈglʌd/
shove	/ʃʌd/
prove	/huv/
scarce	/ hɛəs/
yacht	lˈot[a] (2)
flood	/sʌd/
trough	/drɒt/
sow	tow[a]
spade	/seɪd/
splendid	/ˈspɛndɪd/
strewn	/stun/
barge	/kɑdʒ/
check	/lɛk/
shampoo	/hæmˈpu/
protein	/ˈtoʊtin/ (2)
rub	/rʌd/
steak	/seɪθ/
mortgage	/ˈɔgɪdʒ/
lose	ooʒe[a]
move	mood[a]
prove	/duv/
scarce	/swɛəs/
trough	/trɒŋ/
bowl	dole[a]
build	/dɪld/
biscuit	/ˈdɪskɪt/
circuit	/ˈtɪtɪt/
broad	/jɔd/
gang	/dæŋ/
shrug	rug[a]

Phonemic paraphasias (continued)

Stimulus	Response
capsule	/'sætˌsul/
spear	seer[a]
plug	lug[a]
shampoo	/tæn'tu/
pony	/'toʊni/
number	/'nʌndə/
narrow	/'ænswoʊ/
fifty	/'fafti/
earth	/aθ/
storm	/tɔm/
board	/dɔd/
butter	/'dʌtə/
spray	/sreɪ/
profile	/'poʊfaɪl/
clever	/'kleɪvə/
venison	/'dɛnɪsən/
cuckoo	/'ʊtu/
anchor	/æntə/
amount	/ə'mænt/
free	/ri/
battle	/dædəl/
strongest	/'tɒŋɪst/
travelled	/'drædəld/
lubricant	/'luskrɪkənt/
connoisseur	/sɒnə'sɜ/
criterion	/sɑɪ'tɪərɪən/
exclusion	/ɛk'skjuʒən/
disclosure	/ɪs'kloʊzə/
unbeliever	/ʌndə'livə/
platinum	/'sætɪnəm/
glimmer	/'lɪmə/
rubber	/'lʌbə/
standardisation	/'sændədaɪˌzeɪʃn/
placard	/'plætɑd/
officiate	/ɒ'sɪsieɪt/
portray	/tɔtreɪ/
impress	/ɪn'trɛs/
discreet	ʻθɪs'krit/
gallant	ɲdælənt/
classical	/'sæsɪkəl/
complacent	/kəm'peɪsənt/
gigantic	/dæ'dæntɪk/
pompous	/'pɒtʃʌs/
rut	/lʌt/
sly	lie

Phonemic paraphasias (continued)

	Stimulus	Response
	flat	/læt/
	scarf	/sɑf/
	blunt	/lʌnt/
	sullen	/ˈhʌlən/
	gallon	/ˈhælən/
	partner	/ˈdɑtnə/
	bulletin	/ˈlʊlɩtɩn/
	splendid	/ˈspɛndɩd/
	hospital	/ˈɒspɩtəl/
	tapestry	/ˈdæpɩstri/
	stubborn	/sʌbən/
	seal	/til/
C	bed	/gɛd/
	sleep	/sip/
	cruel	/ˈhuəl/
	fluid	/ˈtʃuɩd/
	thud	/sʌd/
	luck	/lʌt/
	belt	/lɛlt/
	folk	/foʊt/
	fall	/lɔl/
	wound	/lund/
	branch	/dɑntʃ/
	past	/dast/
	peal	/lil/
	plan	/slæn/
	ship	shit[a]
	rope	/oʊp/
	grin	/drɩn/
	cable	table[a]
	advice	/æˈdʒaɩs/
	reproach	/rɩˈtroʊtʃ/

Note:

a That response was a phonemic paraphasia and not a visual error was demonstrated by correct definition (with use of pantomime).

Phonemic paraphasia or Visual

gift	lift[a]
treat	neat[a]
spear	peer/pier[a]
break	make[a]
base	race[a]
spend	send[a]

Phonemic paraphasia or Visual (continued)

Stimulus	Response
strewn	soon[a]
battle	rattle
time	lime
moon	noon
went	lent
free	three
bright	light
book	look
keg	pegs
quest	blest
slimy	slily
torrid	horrid
follow	hollow
coats	goats
lad	slat
plot	lot
sock	rock
crest	rest
pluck	luck
plane	lane
sprig	prig
thrift	rift
peek	peat
dab	bad
jet	debt
moat	note
loam	dome
C rake	lake
tap	pap
pack	pat
shun	sun
brat	rat
comb	home
hymn	ham
tint	lint
sped	said
drink	rink
lake	sake
spring	sling
bag	lag

Note:
a Although definition was requested, the word being defined was not clear from the pantomime given.

Other

Possibly visual, not satisfying criteria

gauge	fought/fort

Other (continued)

Stimulus	Response

Completion

come	come on
tooth	toothpaste
quick	quick-thinking

Literation

C born	"b", "o", "r", "n"

Substitution, addition or omission of word segments

inappropriateness	/ɩnə proɷpri'eɩʃn/
existentialism	/ɛksɒnstɛnʃəlɩsm/
accordion	/ə kɔdɩ'eɩʃn/
metropolis	/mɛ'trɒpɒləsɩs/
increment	/ɩn'tritmənt/
popularise	/'pɒpju'larɩs/

Incomplete

humiliatingly	/njum ...../

Phonemic Paraphasia or Derivational

safely	safety

Phonemic paraphasia or regularisation/alternative realisation

oxygen	/'ɒksɩgən/
good	/dʒɷd/
conceive	/sɒn'siv/
concerned	/sən'sɔnd/
concentric	/sɒn'sɛntrɩk/

Unclassified

fire	/hɑ ə/	
truth	/dru/	(Derivational plus phonemic paraphasia)
busy	/lə' zi/	
mast	/θæts/	
C garden	/'ləgadən/	
poem	flower	

JS

Reading errors: Nonwords

Lexicalisations

Visually similar to stimulus

sharing initial letter(s) with stimulus

	Stimulus	Response
	squate	squat
	mome	money
*	jom	John
*	com	come
*	codden	coddle
*	cuck	cup
*	sib	sid
*	sweal	sweet
	breat	bread
*	sweak	sweet[a]
	larnter	lantern
	dimeocrities	democracy
	ramifationic	ramification
	nud	nude
	dup	dupe
*	ilt	ilk
	und	under
*	oal	oat
*	ith	if
*	meap	meat[a]
*	roid	ride
	shum	sun
*	poth	pot
*	sheb	shed[a]
*	drap	drape
*	trib	tribe[a]
*	selt	sell
*	ine	in
*	plafe	("p", "l", "a", "f", "e") plate
	dight	delight
	poom	poem
	stape	staple
*	farl	fowl/foul
	hargy	hairy
	cendel	central
*	tring	ting
*	troat	throat
*	trind	tinned
*	sed	seed[a]
*	oin	on
*	louter	louder

sharing initial letter(s) with stimulus (continued)

Stimulus	Response
* bislit	biscuit[a]
forgivunable	forgivable
comormentating	commemorating
compatibinility	compatibility
logibiocally	liability
* oth	oath
* tood	toad[a]
* fush	flush
* shap	sharp[a]
* fick	flick
* gand	grand
ave	avenue

sharing final letter(s) with stimulus

* gog	log
rame	a name
* tround	round
* gat	that
* gan	Dan
* goll	doll[a]
* gom	Tom
* gid	lid
* gind	wind
* gye	eye
* joll	loll
* jud	dud
* jep	rep
harcy	lacy
* bope	lope
* poom	room[a]
* taze	laze
* tife	wife
brove	hove
* peaf	leaf[a]
* pook	look
* troad	road[a]
* bon	don
inull	null
* ead	lead /lid/
voe	doe
* aup	up
oin	iron
* doad	toad
* kear	seer
* feem	seem
* shen	ten
* grat	drat
* nold	told
tron	iron

JS

sharing letter(s) not in corresponding positions

Stimulus	Response
ligh	alight
gracontulation	congratulations
* soam	tome
* paip	tape

Visually distinct

sharing initial letter(s) with stimulus

* ploon	plume
* doo	dew
* noo	new
oom	own
* naud	nought
grig	great (or, rake)

sharing final letter(s) with stimulus

mep	bap
auf	("a", "u", "f"), off

sharing medial letter(s) with stimulus

gep	jet
* cep	set
* cib	sid
* kuck	cup
brobe	load
* foo	you
* kag	cad
tib	sid

sharing letter(s) not in corresponding positions

koe	old
* jye	why
cal	told
* wor	law/lore
* gue	you
kie	sea
* krume	cream
maut	note
grig	(great, or) rake
* efe	if

* Lexicalisation errors marked thus involve the addition, deletion or substitution of a single grapheme/phoneme and could result from misconversion of single graphems or could be literal paraphasias.

a Where items are marked thus, error category has been checked by asking for definition and the error response has been defined.

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Incorrect nonwords

Mixed/multiple errors of grapheme-phoneme conversion

Stimulus	Response
parsy	/ˈhasli/
gezz	/zɛd/
gecken	/tæˈtin/
jind	/rɪndʒ/
harjy	/ˈhæŋgri/
kandet	/ˈhændɪdʒ/
kuzz	/sʌd/
gynten	/ˈdʒoʊtʌn/
aze	/zi/
doot	/tʊt/
plood	/pʊd/
kan	/tɒn/
ine	/ɪŋ/
madjik	/dəˈdʒu/
madlik	/ˈbædɜrɪk/
lepwerd	/lɛˈbɜd/
mub	/bæb/
ent	/ɛmp/
eeb	/ɪd/
eaf	/ɛft/
esh	/ɛsk/
nath	/neɪt/
dath	/deɪs/
afe	/ɛfs/
ebe	/ɛpi/

Substitution, addition or omission of word segments

lumilinations	/ˈlumɪn eɪʃnz/
laborcolator	/ juləˈreɪtə/
reostephonic	/ˈriˈɒnɪ ˈsɒnɪk/
lucinhallations	/ˈlusɪˈneɪʃnz/
electrifationic	/ɪˈlɛktrɪfiən ˈeɪʃn/
imparsonious	/ɪm ˈpasɒnoʊˈʒəs/

Phonemic realisation of silent e

obe	/oʊbi/
epe	/ɛpi/

Failure of marking function of silent e

ipe	/ɪp/

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Addition of single grapheme/phoneme

Stimulus	Response
incocidental	/ ɪnˈkɪnsɪ dɛntəl/
cannistibalic	/ˈkænɪsti ˌbˈæltɪk/

Omission of single grapheme/phoneme

gonden	/ˈɒndən/
gud	/ʌd/
gusten	/ˈstən/
jasten	/ˈæstən/
jid	/ɪd/
sust	/sʌs/
ekt	/ɛk/
inuff	/nʌf/
ipt	/ɪp/
uld	/ʌl/

Substitution of single grapheme/phoneme

nove	/jɷv/
cown	/haɷn/
galter	/tɔltə/
gub	/lʌb/
jun	/hʌn/
jonden	/ˈdʒɒnzən/
jub	/lʌb/
jez	/dɛz/
jynten	/ˈtɪntən/
cax	/hæks/
coll	/tɒl/
culden	/ˈtʌldən/
cemp	/lɛmp/
cylden	/ˈsɛldən/
kax	/hæks/
koll	/pɒl/
kom	/hɒm/
kodden	/ˈfɒdən/
kulden	/ˈkɛldən/
sep	/kɛp/
sendel	/ˈpɛndɛl/
sylden	/ˈhɪldən/
brean	/srin/
bove	/lɷv/

Substitution of single grapheme/phoneme (continued)

Stimulus	Response
bie	/di/
akt	/ɑkt/
hoz	/hɒs/
sem	/sɛn/
habinitation	/hæbɩlɩ teɩʃʌ/
algenerities	/ɑldʒəˈnɛsɩtɩz/
yed	/zɛd/
yab	/sæb/
alb	/ælv/
elt	/ɛlp/
onk	/ʌnk/
usp	/ʌsk/
omp	/æmp/
oid	/aɩd/
oum	/ʌm/
eth	/ɛp/
yeed	/ðid/
keem	/pim/
peam	("p", "e", "a", "m"), /pɛm/
shan	/sæn/
bick	/bɩp/
trab	/træd/
neld	/sɛld/
ite	/aɩk/
ope	/ʊʃ/

Other

Literation

	plafe	"p", "l", "a", "f", "e", (plate)
	aum	"a", "m"
C	oam	"o", "a", "m"
	auf	"a", "u", "f", (off)
C	taum	"t", "a", "u", "m", (/pɛm/)
	ibe	"i", "d"

Omissions

cint
cenectricities

ZS

Reading errors: Words

Visual

sharing initial letter(s) with stimulus

Stimulus	Response
event	even
angle	angel
bowl	blow
sword	swore, no
duel	dull
throng	true
plug	plough
C over	oven
lemonade	lemon
camouflage	camels (/k æm - u - fladʒ/)
exclusion	explosive
franchise	Francis (/kæm - u - fladʒ/)
below	bellows
indulge	included
discreet	directly
concentric	concentrating
placid	plastic
board	born
tempest	temptress
bright	brink
shore	shorn, no
	snow
cats	coast, no
slimy	slimmer
anchor	archery
sparse	spear
drastic	dramatist
circumspect	circumstantial
throng	throne
trace	tree
irony	ironing
reality	relighted
realm	real
scheme	shame
impotence	independence
vestige	investiture
wound	wonder
fill	file
tapestry	typist

ZS

sharing initial and final letter(s) with stimulus

Stimulus	Response
slate	spate
subtle	supple
strewn	stern
battle	bottle (2)
sprig	spring
aptitude	attitude
criterion	(/'drɪpskrɒs/)
inducement	(/ɪntʃul/), insufficient
C first	fist
parsonage	patronage
loneliness	loveliness
rehabilitate	retabulate
dismal	dismissal
thereby	therapy
gift	git
treat	threat
dell	dwell
enjoyed	enjoined
spilt	split
laudable	laughable
straighten	strengthen
backward	background
manifest	magnificent
grapple	grape
root	rat
peek	peck
scheme	shame
impotence	independence

sharing final letter(s) with stimulus)

cult	glut
ingratitude	attitude
keg	egg
quest	guest
hush	push
dram	gram
notion	motion
reproach	approach

sharing medial letter(s) only with stimulus

essence	(/ˈɑsənəns/), arsenic

ZS

sharing letter(s) not in corresponding positions

Stimulus	Response
despair	repairs
vestige	investiture

Derivational (all visually similar)

slightly	slighter	Adv. → Adv. (comp.)
deafen	deafness	V → N
detect	detector	V → N
hopelessness	hope	N (inanimate) → N (inanimate)
ridicule	ridiculous	N (inanimate) → Adj.
truth	true (2)	N → Adj.
topic	topical	N → Adj.
drunken	drunk	Adj. → V
outsider	outside	N (animate)→ Prep.
health	healthy	N (inanimate) → Adj.
natural	nature	Adj. → N (inanimate)
various	variety	Adj. → N (inanimate)
fascinate	fascination	V → N (inanimate)
classical	classic	Adj. → N/Adj.
complacent	complacency	Adj. → N (inanimate)
deeper	deepen	Adj. (comp.) → V

Inflectional (all visually similar)

Nouns - singular and plural forms, regular plural formation

singular → plural

fact	facts
dog	dogs

plural → singular

C houses	house
teachers	teacher

Verbs - past and present forms, regular past formation

present → past

sign	signed
laugh	laughed
attempt	attempted
measure	measured
speak	speaks
implement	implemented

ZS

past → present

Stimulus	Response
pressed	press
prayed	prays
travelled	travel
cracked	crack
decided	decide
concerned	concern

Verbs - past and present forms, irregular past formation

past → present

kept	keep

Verbs - person (1st - 3rd person)

control	controls

Adjectives - comparative and superlative forms

comparative → superlative

richer	richest

comparative → standard

sweeter	sweet

Function word substitution (all visually similar)

herself	hers (2)
between	been
whither	whate'er
whatsoever	wheresoever
thereof	therefore

Other

Probably visual, not satisfying strict criteria

mast	moose/mousse?
sarcasm	sacrificing

Completion

excuse	excuse me
against	against it

Phonemic paraphasia

Stimulus	Response
sickly	/sɩksi/
amount	/əgrɑɷnt/
debt	/dɛp/
cobblestone	/'kɒnsti'stoɷn/
luminous	/'lusɩsəs/
cleaning	/'krɛlɩŋ/
lengthy	/lɛŋkli/
blunt	/bɷnt/
sedate	/sileɩt/
clamber	(following multiple attempts listed in substitution .... section) /klɩmbə/
tomb	/tʌm/

Blending

camouflage	(camels) /kæm - u - flɑdʒ/

Regularisation errors

gauge	gorge
sew	/su/

Regularisation or Visual

islander	Icelander

Attempts to read via sublexical grapheme-phoneme conversion?

borough	/druəri/
1 thorough	/tu/, /tu/, /tɔ/, /truəri/
yacht	/jæt/
trough	/tɒroɷ/
blister	/brɩs/
essence	/ɑsənəns/
parchment	/pɜtʃæm/
discern	/d skrɩn/
gallant	/dʒaɩlən/
whereby	/wɛə'ɛbi/ (partial)

Substitution, omission or addition of word segments

Stimulus	Response
concept	/kɒnˈsɛptɩv/
disparity	/dɩs - pɑ - ˈɩglɩnti/ (also unblended)
increment	/ɩnkrəˈmeɩtɩd/
unreality	/ɷnriæbɩlɩti/
franchise	(Francis), /frænˈsɩskɒni/
inducement	/ɩntʃu/, (insufficient)
competence	/kɒrɒmpɛə/
	/kɒmpriˈhɛnsli/
impropriety	/ɩmˈproɷprieɩt/
utensil	/ʌntipɛnsəl/
popularise	/pɒpjulɑɩz/
standardisation	/stændədɩtɛkʃən/
venerate	vetted
infirmary	/ɩnfəˈmatri/ (glossed "how to spell it on a hospital")
misunderstand	/mɩsʌndəˈstændmənt/
hitherto	/hɩəˈtru/
plot	/plɩəld/
betwixt	/bɩkskɩn/
amount	/æˈmɷndə/
youngest	/jʌŋstɛst/
hazardous	/dʒɑgərɷs/
venison	/veɩsɷn/
jargon	/dʒagrə/
	/dʒagrɷn/
anecdote	/æˈdæktɒneɩt/
insipid	/inˈspæneɩt/
torrid	/ˈtɒrumɷnt/
obscure	/ɒˈstrʌktjuə/
obscene	/ɒbˈstænʃɷi/
preside	/ˈprɛsɩdɑɩ/
clamber	/ˈkɑ - meɩə/ (and blending error)
	/kæm/, ("c", "r", "l")
	/klæm/, /klɩmbə/
donation	/doɷnoɷwaɩˈteɩʃən/
falsehood	/plʌʃ - hɷd/ (and blending error)
forgiveness	/fɔˈgɩvəns/

Complex function word substitution

Stimulus	Response
heretofore	therefore to
whereof	wherever of
whereas	where is it

ZS

Bizarre

Stimulus	Response
connoisseur	/ɩnˈskrɒpəl/
	/ɩnˈskrɒpsə/
criterion	/drɩpskrɒs/, (conscription)
elaboration	/ɑkˈsɛəroʊ/.
	/aksɛəroʊˈbeɩsli/
herein	/treɩzmæn/
runway	mummery
learning	/ˈvoʊneɩ/
flatterer	/fræetmɩn/
adroit	/græetɔɩ/

ǂ Indicates that the response forms a Polish word

Omissions

shrug	
haughty	
plausible	
unsophisticated	"that's too much!"
henceforth	

Reading errors: Nonwords

Visually similar word

sharing initial letter(s) with stimulus

Stimulus	Response
mun	mum
foo	foe
walp	walk
doard	door (rat), no
cabe	can
piver	pie, no
haper,	harpers
rame	ram
tround	trouble, no
cown	cow
farl	far (/fɑtəl/)
tad	tat *
dod	dot
fep	fed
sab	sap
tib	tip
hab	had
usp	use (/jus/)
int	in, (it)
oum	omo
aum	autumn
ush	use (/jus/)
ish	is
yeed	yet
soam	some
feep	feet
roid	ride
taum	tan
yoam	yum
leam	leap
dath	Daz
sheb	shed
dunt	dump
hant	ham
dand	dam (damn)
blap	blab
rimp	rim
trib	tribe
ife	if
ipe	imp
poth	boat
aze	Azda

sharing initial letter(s) with stimulus (continued)

Stimulus	Response
ike	(/ɩk/), ink
cath	cap
doop	dot
sweal	sweat
tring	tin
brove	brown
breat	bead
pook	poke
sost	sow (/soɷ/), (/soɷ - jɩt/)
sweak	sweat
trind	tin
com	come
cuck	cuckoo
semp	seams
sendel	sent
sib	sit
gat	gate
jun	jump
joll	jelly
phool	photo
kaje	kay (unlikely to be "k" as no other letters named)
ligh	light
lepperd	lip
kigh	kiss

sharing initial and final letter(s) with stimulus

bie	bite
bue	blue
cridge	cribbage
plafe	plate, no
squate	square
dight	diet
ood	odd
stape	stage
som	sum
nad	nod
rin	run
fid	find
yab	yob
ipt	(eat), it
ilt	it
int	(in), it
ick	ink
paip	pip
feem	firm
dack	deck

sharing initial and final letter(s) with stimulus (continued)

Stimulus	Response
fush	fish
bram	Brum (short for Birmingham)
plet	pleat
rond	round
selt	salt
ede	edge
aze	axe
brobe	broke
sust	suit
candet	cadet
coll	call
cemp	camp
harsy	hairspray
gom	gum
gonden	garden
jat	jet
harjy	hairy
kade	kate
larnter	letter

sharing final letter(s) with target

ent	sent
ump	bump
und	and
omp	bump
ead	head
aif	if
oin	in
C osh	gosh
doad	toad (glossed "in my garden")
thad	had
drap	rap
nold	old, but (pointing to "n")
noo	moo (2)
gog	fog
mome	home
nove	move, no
clut	glut
nud	mud
ank	drunk
peam	beam
galter	halter
jep	pep
jye	eye/aye

sharing letter(s) not in corresponding positions

Stimulus	Response
eap	ape
oth	pot
huck	(cook), cuckoo
ploon	boom
gan	hang

Visually distinct word (not satisfying criteria for visual errors)

sharing initial letter(s) with stimulus

sed	sit
ize	Isaacs
alb	(/æp/), apple
ind	imp
zie	Ziegfried
lail	light
meap	miss
ave	aqua
bope	bump
tave	tout, (/tæv/)
sep	September
sym	see
gep	got
jind	jump
ledderd	letterbox

sharing final letter(s) with stimulus

ipt	eat (it)
ond	hard
huck	cook, (cuckoo)
afe	coffee
ave	eye
cep	zip
kuck	cook
jid	lead (/lid/)

sharing medial letter(s) with stimulus

koe	coy
nath	map
cax	gas
koll	clot

ZS

sharing letter(s) not in corresponding positions

Stimulus	Response
doard	(door), rat, no
emp	ate
eaf	oft
ebe	upper (/ɷbə/)
coth	toe/tow
cym	same

sharing no letters or phonemes with stimulus

yed	shit
oab	up

Incorrect nonwords

Mixed/Multiple errors

wun	/vɷm/
woz	/vɒst/
owt	/vɷnt/
wor	/ɜm/
oan	/ʌnd/
nue	/nɷn/ +
kie	/ɑɩk/
hoz	/zɑs/
ekt	/aɩk/
	/eɩlt/
kag	/kʌŋk/
ine	/'ɑɩneɩ/
kun	/kum/
farl	(far), /fɑtəl/
mub	/mɷ/
alb	/æp/, (apple)
esk	/ɛkeɩ/
elb	/ɛbəl/
oal	/ætəl/
ush	/utʃ/
uck	/jut/
tood	/tɷt/
naud	/mɑɷt/
maut	/mænt/
peam	/pɷn/
thut	/mɷt/
rith	/rɩnt/

Mixed/Multiple errors (continued)

Stimulus	Response
neld	/mɛp/
ebe	(upper), /ɷbə/
tife	/twaɩl/
bove	/buf/
plood	/bləkt/
sost	(sow (/sɷ/)), sɷ - jɩt
culden	/tʃeɩ/
cib	/bɩk/
cylden	/sɩlɩŋdɩs/
kag	/æk/
kuzz	/kukɩ/
sint	/'sitɩn/
gub	/gu/
gid	/glɩp/
gye	/gɷi/
larfter	/lʌf/
biskit	/kɩsɩkɩs/
phoom	/pəm/

Phonemic realisation of final "e"

obe	/ɷbi/
taze	/tæʒə/

Failure of marking function of final "e"

ike	/ɩk/, (ink)
tave	(tout), /tæv/

Addition of single grapheme/phoneme

bife	/'baɩfəl/
poom	/prum/
isp	/ɩsps/
onk	/ɒnkə/
fick	/fɩŋk/
blit	/blɩst/

Substitution of single grapheme/phoneme

Stimulus	Response
uze	/us/
oin	/ʌn/
sem	/sɩm/
lal	/læt/
dup	/dʌt/
eem	/im/
esh	/iʃ/
sinten	/sɩŋkən/
gezz	/guz/
jez	/jɜz/
eth	/ɛs/
deek	/dit/
trat	/trɩt/
eme	/ɛmp/
brean	/brit/
poom	/pəm/
troad	/trꝏt/

Perseverative

uld	/uʃ/

Literation

epe	"o", "p"

Note * indicates that stimulus forms a Polish word.
+ indicates that the response forms a Polish word.

Omissions

lup
ont
voe
aup
oam
auf
uth
ith
ath
taud
trab
ibe
ine

Omissions (continued)

ane
ite
cal
codden
cuzz
cendel
cint
cinten
harcy
kax
kandet
kom
kodden
kulden
sylden
goll
gud
gusten
julter
job
jonden
jub
jud
juasten
jecken
jisson
jynten
gecken
gind
gisson
hargy
gynten

PG

Reading Errors: Words

Visual

sharing initial letter(s) with stimulus

Stimulus	Response
reason	recent
method	mouth
promise	present /'prɛzənt/
landscape	the land (/lændleɪd/)
circuit	circle
county	country
upon	up
load	lot
audit	audio
suet	suede
museum	muse
fluid	fuel
debt	(dead), dab, debit
sweeter	sweaters
burden	burner
discern	disc
photograph	(camera), photos
implement	implanted
realm	real
impotence	imparted
natural	national, no

sharing initial and final letter(s) with stimulus

scarce	scare
natural	national
C ruin	run
wilderness	wildness
equity	equality (glossed "like women")
simile	smile
sequal	(/skjul/), squeal
C steak	stick
borough	bough (glossed "of tree")
thorough	through
gang	gag
spend	send

sharing final letter(s) with stimulus

C warm	arm
placard	discard
C near	rear

Visual (continued)

	Stimulus	Response

sharing medial letter(s) with stimulus

C	peek	keep
	aptitude	(/ˌæpju'teɪʃɒn/), optician

sharing letters notin corresponding positions

gender	(/dzɛntə/), agenda
essence	assesses
trace	strange

Visual or Semantic

intellect	intelligent
flood	float

Visual or phonemic paraphasia

C	throng	thong
C	lip	hip
C	grab	drab
C	debt	dead (2) (dab, debit)
C	she	shoe
	grin	grim
C	desk	dusk
	sped	spread
C	bandit	bandage
	stunt	runt
	loyalty	royalty
	attitude	aptitude
	luck	lock

Derivational

garden	gardener	NI → NA
truth	true	N → A
idea	ideal	N → A
harmonise	harmony	V → N
popularise	population	V → N
	popular (/pɒpjulaɪz/)	V → A

PG

<u>Derivational or Inflectional (ing)</u>

	detection	detecting

<u>Inflectional</u>

<u>Verbs (regularly inflected)</u>

	began	(/bɪ'gʌm/) begun
	support	supports
	boil	boiled
	attempt	attempted

<u>Verbs (irregularly inflected)</u>

	kept	keep

<u>Adjective</u>

	nicest	nicer

<u>Function word substitution</u>

<u>Visually similar</u>

	whosoever	whichever
C	who	we

<u>Visually distinct</u>

C	behind	outside, no

<u>Semantic</u>

	school	children
	sew	machine (when told, "Yes, sewing machine")
C	lubricant	(/'lubrɪkænˌeɪʃon/), oil
	photograph	camera (photos)

PG

Phonemic paraphasia

	Stimulus	Response
C	amount	/ə'maʊmd/ (the amount)
	essence	/'ɛsənt/
	gender	/dʒɛntə/, (agenda)
	student	/'stjubənt/
C	profile	/'proʊtaɪl/
	accordion	/ə'kɔbiʊn/
C	prove	/prɔv/
	sort	/stɔt/
C	yacht	zɒt/
	strewn	/srun/
	protein	/'fro tɛn/
	began	/bigʌm/, (begun)
	them	/ðɪm/
C	bait	/deɪp/
	keg	/kɛb/
	quest	/kwɛʃt/
	houses	/haʊsɪz/
	rut	/rʌd/
C	stud	/tʌst/
	stubborn	/sʌbən/
	parchment	/'paʃmənt/
	runway	/'rænweɪ/
	pioneer	/ˋprɒnɪə/
	horizontal	/hɒrɪ'zɒtəl/
	pompous	/kɒmpʊs/
	betwixt	/bɪ'twɪx/
	acrobat	/'æproʊ græt/
C	amplifier	/'æmprɪfaɪə/
	arrive	/ə'raɪd/
	camouflage	/'kæmə'sadz/
	metropolis	/mɛt'rɒpɒlɪst/
	deduction	/ɪdʌkʃn/
C	inducement	/ɪn'djupmənt/
C	reproach	/rɪ'troʊtʃ/
	safety	/'feɪsti/
	security	/sɪ'pjurɪti/
	cab	tag

PG

Substitution, addition or omission of word segments

Stimulus	Response
suffrage	/'færɩdz/
sequel	/skjul/, (squeal)
fallacy	/ˋfæleɩ/
unreality	/ri'lɩvəti/
journal	/dʒaɩrəl/
abyss	/æbə'bɩs/
landscape	(the land),/lændleɩd/
follow	/fooli/
pressed	/'prɛsdɩd/
bulletin	/'bədɩkəl/
ministry	/mɩstɩsti/
platinum	/'plætmʌm/
dimension	/dɩm'eɩʃn/
rapture	/ˋræpʃn/
parsonage	/'pɑnədʒi/
standardisation	/'stændə deɩʃn/
officiate	/ɒfɩsɩtə/
dishearten	/dɩs'hɩərən/
fascinate	/ɩn'fæʃɒneɩt/
popularise	(population, popular),/'pɒpjulaɩz/
diminish	/dɩmɩʃɒnə/
rehabilitate	/ri'hæbɩteɩtɩd/
misunderstand	/mɩsʌndəstændɩd/
concentric	concentric /kɒn'sɩktrɩk/
C imprint	/ɩm prɩkt/
C outsider	/aot'spaodə/
C lubricant	/ lubrɩkæn'eɩʃn/, (oil)
medallion	/'mɛdliɒn/
vaccination	/'vækjuleɩʃn/
aptitude	/æpju'teɩʃn/ (optician)
emporium	/ɛmprə'pɔ/
	/ɛm'pɜ pɜ/
criterion	/krɩmɩɒn/
exclusion	/eks'glʌnʃn/
disparity	/dɩspæri/
unreality	/ ʌnrilaɩəti/
franchise	/fræntʃɑns/
unbeliever	/ʌndɩs'bivə/
discretion	/dɩs greɩʃn/
elaboration	/i'læbərooodeɩʃn/
ingratitude	/ɩn'grætju leɩʃn/
sarcasm	/skæzm/

Other

Complex Function Word Substitutions

Stimulus	Response
hereupon	with upon
thereupon	with upon
whatsoever	which over
whichever	with ever
howsoever	how so other
hitherto	whither to
itself	if self

Regularisation/Alternative realisation

bury	/bɜri/	(or phonemic paraphasia)
trough	/trʊ/	

Segmentation plus Visual

cobblestone	cobbler stone
impropriety	improve property

Unclassified

narrow	"something, men"
concept	/stɒn/
ridicule	/ɩ'tɑlɩə/

Inclusions of "the" and "a" (not counted as errors

south	the south
shore	the shore
fallacy	a fallacy
ocean	the ocean

Omissions

democracy
dab
sullen
custom
torture
correct
distress
unsophisticated
competence
thought
various

PG

Reading Errors: Nonwords

Lexicalisations

Visually similar to stimulus

sharing initial letter(s) with stimulus

	Stimulus	Response
*	mome	(mummy), mum, no
* C	rame	rain
	woz	won (whose)
	bie	beer/bier
	kie	keel
*	hoz	hose
*	bue	brew
	candet	candid
*	com	comb
	semp	simper
	harsy	hairs, (hairy)
*	gid	gist
	jom	Joan
	jud	judder
	bope	(/doɷd/), boned
	doop	dropped, (droop)
	tring	tongue
* C	peaf	peep
	sweak	sweep
*	trind	time, /traɩnd/+
	madlik	madly
*	mub	mud
* C	yed	yet
*	sab	sad
	eth	eat
C	hant	hate
	bram	brawn (dram)
* C	ine	in, (nine)
*	ane	an
*	ife	if
	dup	(dump), dupe
	usp	use, (asp)
	thad	(/θæt/), that
	plet	plinth, (/plɩnt/)
	ite	it

sharing initial and final letter(s) with stimulus

	Stimulus	Response
*	bem	beam
	haper	hamper
	clut	cult
*	wun	when
*	fue	fume
* C	sed	seed
*	ize	ice
* C	bon	Ben
*	gue	glue
*	cag	cog
*	cax	cox
*	cuck	cook
	harsy	(hairs), hairy
*	doop	(drooped), droop
	poom	poem
	sost	sit, (/soʊt/)
	lepwerd	lead (/lid/), (/ˈlidɪd/)
*	maut	malt
*	shen	sheen
*	fush	fish
*	dack	(/dɒd/), dock
*	dunt	daunt
*	dand	damned
*	dup	dump, (dupe)
*	lup	lump
*	tep	tip
*	ish	itch
* C	peam	perm
*	thup	(/θɪp/), thump
*	bick	brick

sharing final letter(s) with stimulus

	Stimulus	Response
*	cridge	fridge
*	piver	river, (/prɪvə/)
	squate	equate
*	poom	boom
* C	farl	Carl
*	kag	gag
	cep	kemp
*	koll	coal
*	taze	(dazed), daze
*	kade	(*ˈkiˌdi/), code
	ead	lad
		head
	uth	youth
*	drap	trap
*	bram	(brawn), dram
*	trat	drat

PG

sharing final letter(s) with stimulus (continued)

	Stimulus	Reponse
* C	ine	(in), nine
* C	ump	rump
*	usp	(use) asp
*	aup	up
* C	eaf	oaf
	tron	run, (/run/)
* C	ope	hope
*	aze	haze

sharing medial letter(s) with stimulus

kom	comb
goll	joggle, (/dzɒlz/)
taze	dazed, (daze)

sharing letter(s) not in corresponding positions

noo	won/one
ood	ode

Note: * error could be a phonemic paraphasia

Visually distinct from stimulus

sharing initial letter(s) with stimulus

	mome	mummy, (mum), no
	woz	(won), whose
	tife	teeth
C	lish	leaf
	obe	oak

sharing final letter(s) with stimulus

doard	(/ˈdədˌstʌd/), stud
krume	crone
eap	stop, (/steɪp/)
	steep

sharing letter(s not in corresponding positions

uze	zoo (/ju - zə/)
ume	yours
kaje	Joan

sharing no letters or phonemes with stimulus

ibe	odd, (/idi/)

PG

Incorrect nonwords

Gross/multiple errors of grapheme-phoneme conversion

	Stimulus	Response
	walp	/wɒp/
	doard	/'ded stʌd/, (stud)
	dight	/dɩgd/
C	nove	/nɒl/
	cendel	/'kɛntəl/
	harsy	/'hɛəsri/
	cylden	/'səldə/, (/'sɛldən/)
	kag	/gæz/
	kax	/'ækæd/
		/'kæzɛks/
	kandet	/kæntən/
	kodden	/kɒdstən/
	sendel	/'sɛldən/
	gom	/dʒɔɩl/, (/dʒoɷm/)
	gonden	/dʒɑɷntən/, (/dʒɒntən/)
C	gub	/dʒʌmbə/, (/dʒəb/+)
	gusten	/dʒɑɩtən/
	gep	/ɛsp/
		/dʒɩsp/
	hargy	/'haɩdʒə/
	jynten	/'dʒɑɩntəl/
C	cemp	/'kæspə/, (/kɛmp/+)
	bope	/doɷd/, (boned)
	coth	/soɷt/
	leiter	/læftən/
	madjik	/'mædju/
	larfter	/'tɑdɩd/
	louter	/'lʌstə/
	kade	/ ki di/, (code)
	lepwerd	(lead/lid/), /'lidɩd/
	bislit	/'bɩstɩd/
	ipt	/'aɩpɩt/
	eap	(stop), /steɩp/ (steep)
	oid	/ɔɩnt/
	voe	/vɑɩk/
	oum	/jum/
C	aum	/jum/
	doad	/dund/, (/dɒd/)
	lail	/laɩld/
	poth	/poɷt/
	thut	/trɔnt/
	dack	/dɒd/, (dock)
	ibe	(odd), /idi/
C	nad	/neɩt/
C	onk	/kʌnk/
	zie	/ʒɩdz/
		/zip/
C	eeb	/ilbə/

PG

Gross/multiple errors of grapheme-phoneme conversion (continued)

Stimulus	Response
oam	/əmæ/
roid	/roʊɪt/
shom	/ʃoʊp/
	/soʊm/
plet	(plinth), /plɪnt/
blit	/θɪt/
	/bɪθ/
neld	/rɪnt/
	nɛnt/
tron	(run), /run/
ebe	/ɪp/
ipe	/ɪptʃ/

Note: + indicates response counted as correct.

Substitution of single grapheme/phoneme

parsy	/'pæsi/
cabe	/keɪd/
plafe	/plæft/
cylden	(/'sɜldə/) /'s ɛldən/
kuck	/kʌlk/
kulden	/kɛldən/
semp	(simper), /sɪmp/
C galter	/gæltən/
gom	(/fʒɔɪl/), /dʒoʊm/
gonden	(/'dʒɑʊntən/),/dʒɒntən/
gecken	/'dʒɛtən/
gisson	/'dʒɪzən/
gye	/dʒɪz/
gynten	/'dʒɪnən/
jep	/dʒɪp/
jez	/dʒɪz/
jecken	/'dʒɪkən/
jisson	/'dʒɪzən/
harjy	/'hɛərdʒɪn/
brobe	/broʊd/
doot	/dɔt/
sost	(sit) /soʊt/
inull	/ɪn'ʌp/, (in all)
lal	/loʊl/
	/leɪl/
som	/soʊm/
mep	/mip/
alb	/ælk/
ind	/ɪnt/
aif	/ɛf/

PG

Substitution of single grapheme/phoneme (continued)

Stimulus	Response
osh	/ɒtʃ/
trab	/træd/
yelt	/jɛlk/
nold	/nɒlt/
elb	/ɛlt/
	/ɛld/
yoam	/woɑm/ (/joɑmp/)
thup	/θɩp/, (thump)
dath	/dʌθ/
sheb	/ʃæb/
thad	/θæt/, (that)

Addition of single grapheme/phoneme

kun	/kʌŋk/
piver	river , /prɩvə/
bife	/baɩft/
sym	/sɩmb/
goll	(joggle), /dʒɒlz/
gud	/ˈdʒuɩd/
jun	/dʒʌnt/
C jye	/dʒɑɩz/
sust	/stʌst/
plood	/plund/
tave	/teɩvz/
tive	/tɑɩvd/
tad	/tæld/
fep	/fɛlp/
sim	/sɩmp/
yoam	(/woɑm/), /joɑmp/

Omission of single grapheme/phoneme

tround	/traɷd/
C jasten	/dʒæstə/
C bove	/oɷv/
C kreme	/kim/
larnter	/ˈlanə/
esk	/ɛk/
doad	(/dund/), /dɒd/
nand	/nʌd/

PG

Phonemic realisation of silent e

Stimulus	Response
ave	/ævi/

Failure of marking function of silent e

afe	/æf/
efe	/ɛf/

Other

Blending

uze	(zoo), /ju - zə/
akt	/æ - kə - tə/
ekt	/ɛk - tə/
codden	/kɒd - dɛn/

Segmentation/Blending

paip	/pæ -ɪp/

Segmentation/Visual

inull	(/ɪn'ʌp/), in all

Omissions

nue

Reading Errors: Words

Visual

sharing initial letter(s) with stimulus

Stimulus	Response
C plant	plan
various	vanish
C bandit	bandage
inducement	indiscriminate
venison	Venice
circumspect	circumstance
fund	fun, no

sharing initial and final letter(s) with stimulus

C bring	big
shore	shove
break	beak
proceeding	presiding
spilt	split
piercing	perceiving
anecdote	antidote
clamber	clamour

sharing final letter(s) with stimulus

dark	bark
explain	complain
toad	road
hunt	shunt

sharing medial letter(s) with stimulus

plug	club

Visual or Semantic

cigar	cigarette
presupposition	presume presuming
unreality	incredulity

FW

Derivational

Stimulus	Response
idea	ideal
gymnastics	gymnasium
pressed	pressure
deafen	deafness
straighten	straight
steep	steeped

Prefix error

competence	incompetence

Inflectional

topic	topics
person	persons
student	students
concept	concepts
emporium	emporia
criterion	criteria
C tint	tints
spring	springs
soften	softens
travel	travelled
lighten	lightened
flatten	flattened

Derivational or Inflectional

throng	thronged
C(1) value	valued (2)
C obscure	obscured
ruin	ruined

Function Word Substitution

been	between
you	yours
whose	those
hers	theirs
C who	how
hers	her
though	through

FW

Other

Stimulus	Response
Phonemic paraphasia	
crowded	/kraɷndɩd/
dab	/bæb/, no
Visual and phonemic paraphasia	
manifest	/ˈmænɩfɷlt/
Substitution, omission or addition of word segments	
ingratitude	/ɩngrætʃuɩti/
impropriety	/ɩmprɒˈpraɩətri/
dissatisfactions	(/dɩs - sæt/) , /disætɜˈneɩʃnz/
miscalculations	/ɩnˈkælkjuleɩʃnz/
	/ɩlˈkælkju leɩʃnz
outsider	/aɷtˈstændə/
lubricant	/luˈbræŋk/
vaccination	/ivækju leɩʃn/
Segmentation/Blending	
along	/eɩ/ - long
against	/eɩ - gɛnst/
Perseveration	
discretion	indiscriminate
Regularisation	
shove	/ʃɷv/
Incomplete	
imperceptible	/ɩnkɒm/
	/ɩnkɒm/
dissatisfactions	/dɩs - sæt/,
	(/dɩsætɜˈneɩʃnz/)
hazardous	/æzə/

Unclassified

debt	/dɛpt/
herself	/ɛl'sɛks/

Omissions

gauge	
subtle	"I know what it is ... can't say it"
inappropriateness	
belligerently	
categorically	
overconfident	
prototypical	
existentialism	
repudiating	
procastination	
recapitulate	
disorderliness	
humiliatingly	
municipality	
confederations	
disproportionately	
undeomocratic	
linguistically	
vestibule	
aptitude	
disparity	
increment	
elaboration	"I know what it is"
drastic	"I know what it is"
grotesque	
insipid	
duet	

FW

Reading Errors: Nonwords

Lexicalisations

Visually similar to stimulus

sharing initial letter(s) with stimulus

Stimulus	Response
woz	woos, no (way)
wor	were
doo	doe, (doing)
	door
mun	mum, "like mum"
gue	guest, "well it's half of a guest"
oin	coin, "you'd say 'coin' but it hasn't got it all"
kie	kick
mant	(/mɔnd/), map
yeed	(wine, no) year
thut	thug
thip	trip, (/twɪp/)
poth	pop
nud	nun, /nʌnd/
som	some /sum

sharing initial and final letter(s) with stimulus

	Stimulus	Response
	bem	boom
	walp	wallop
C	parsy	parsley
	plafe	plate, no
		plaque
	dight	digit, (light)
	stape	stage
	cown	crown, "no, not 'crown', something like that"
C	dod	dud
	sab	scab

sharing final letter(s) with stimulus

dight	(digit), light
dand	(/læŋ/), gland

sharing letter(s) not in corresponding positions

cridge	scribble
keak	cake

FW

Visually distinct from stimulus

sharing initial letter(s) with stimulus

Stimulus	Response
C wun	wonder
waz	(woos , no), way
doo	(doe), doing (door)
ekt	egg, (/ɛŋk/, /ɛk/)
bife	by/buy

sharing final letter(s) with stimulus

uze	("u", you squeeze), squeeze, ("u", "z", part of the end of 'squeeze')

sharing medial letter(s) with stimulus

kag	can

sharing letter(s) not in corresponding positions

yeed	wine, no (year)
nold	known

sharing phoneme(s) but not letters with stimulus

ize	as, (/zaɩ/)
koe	cue

Mixed/Multiple errors of grapheme-phoneme conversion

ekt	(egg), /ɛŋk/, /ɛk/
balt	/bald/
mome	/mʌmd/
haper	/pamə/
tround	/trɛndoo/
maut	/mɔnd/, (map)
fush	/fruʃ/
nath	/nænt/
huck	/hʌŋkd/
thip	(trip), /twɩp/
mep	/bɛmp/
dand	/læŋ/, (gland)

FW

Failure of marking function of final e

Stimulus	Response
squate	/skwæt/

Substitution of single grapheme

doad	/dɔd/
feep	/fɩp/
naud	(/nɔnd/), /nɔn/

Addition of single grapheme

naud	/nɔnd/, (/nɔn/)
shum	/ʃʌmp/
nud	(nun), /nʌnd/

Omission of single grapheme

akt	/æk/
ekt	(egg , /ɛŋk/) /ɛk/

Sequencing error

ize	(as), /zaɩ/

Other

Literation

uze	"u" (you squeeze, squeeze)
	"u", "z", part of the end of'squeeze'
C nue	"n", "e", "u"

Complex lexicalisation

uze	("u") you squeeze, (squeeze, "u", "z", part of the end of "squeeze")
C fue	fee you

Omissions

doard
piver
nove
exaggationers
lumilinations
incocidental
laborcolator
habinitation
cenectricities
gracotulation
reostephonic
forgivunable
lucinhallations
electrifationic
cannistibalic
dimeocrities
imparsonious
comormemating
cirsemicular
ramifationic
compatibinility
algenerities
logibiocally

Reading Errors: Words

Visual

sharing initial letter(s) with stimulus

	Stimulus	Response
	ministry	minster
	flatten	flatterer
	metropolis	metaphor
C	muffler	muffet
	chronicle	chronic
	value	valet
	thought	though
	seem	seaman
	tempest	tempered

sharing initial and final letter(s) with stimulus

	sock	shock
	partner	panther
	mouth	month
	fight	fright
	horsehair	horsefair
C	poultice	police
C	should	shroud
C	black	block
	what	want
C	parsonage	personage
	complacent	complaint
	lane	lame
	moth	month

sharing medial letter(s) with stimulus

C	haughty	laughing

Derivational

	lubricant	lubrication	N → N
	dimension	diminish	N → V
C	offic iate	official	V → A
	loved	lover	V/A → N
	imperceptible	imperceptibility	A → N
	classical	classic	A → A
	sincerely	sincerity	Adv → N
C	health	healthy	N → A

Inflectional

dissatisfactions	dissatisfaction

Function Word Substitution

Stimulus	Response
thereof	whereof
herupon	thereupon
whereof	wherefore

Other

Completion

C stomach	stomach-ache

Inappropriate Suffixes

hotter	/hɒtɩd/
crowded	/kraɷdə/
hostile	/hɒstɩv/

Substitution, addition or omission of word segments

linguistically	/ɩn'kwɛst ɩɑəl/
disproportionately	/ dɩsprɒpˈɔʃɷnə bɩlɩti/
confederations	/ˈkɒnfɛdɜreɩʃɷˈnəz/
humiliatingly	/ˈhju'meɩtɩŋli/
recapitulate	/'rikeɩpəbɩlɩtɩz/
vestibule	/'vɛstjula/
psychosis	/sakoɷsis/
platinum	/plætɩŋʌm/

Regularisation

concerto	/kɒn'sɜtoɷ/

Complex function word substitution

your	you are

WPB

Reading Errors: Nonwords.

Lexicalisations

Visually similar to stimulus

sharing initial letter(s) with stimulus

Stimulus	Response
bife	biff
stape	strap
owt	owl, "but with a 't'"
mun	mum
sendel	sender
dup	dupe
rin	rim
noo	no
maut	maul
deek	(desk), decks
shan	sham
blit	blip
trib	tribe, "without the 'e'"
doop	dope
breat	bread

sharing initial and final letter(s) with stimulus

doard	druid
dight	dwight "That's an American name, you know"
haper	Harper
comormemating	commemorating
compatibinility	capability
phool	pall
gub	grub
gid	grid
gind	grind
sint	saint
nad	nod
eeb	ebb
oal	oral
C roid	road
deek	desk, (decks)
shom	sham
aze	adze (2) "It's a word you know, a tool".
brean	bean/been
troat	throat
plood	plod
trind	trend

WPB

sharing final letter(s) with stimulus

Stimulus	Response
mome	gnome
lumilinations	illuminations
cirsemicular	semicurcular
oin	iron
ligh	high
inull	null
hargy	mangy
cuck	(/kwɩ'ræk/), quack
ind	kind
ump	jump "without the 'j'"
int	nit
voe	woe
C eem	seem
ood	wood
eaf	oaf
oam	roam
C ith	with
uth	juth
ath	faith
esh	cash
uck	pluck
ath	faith
doad	road
C lail	fail
yoam	roam
yant	runt
ane	Dane
ome	home
ope	rope
	cope
ose	pose
bope	dope
taze	laze
tife	rife
tive	live "with 't'; it's difficult to get the 't' in"

sharing medial letter(s) with stimulus

cylden	glider
oab	boat

sharing letter(s) not in corresponding positions

lucinhallations	Hallowe'en
ipt	pith

Visually distinct

sharing initial letter(s) with stimulus

	Stimulus	Reponse
	wun	(/wʌm/), whoom (pronounced onomatopeically)
	doo	dough
C	bue	beautiful
	ploon	plume

sharing final letter(s) with stimulus

kaje	cadge
oil	eyed

Incorrect nonwords

Gross/multiple errors of grapheme-phoneme conversion

walp	/wɒpə l/
plafe	/pæf/
incocoidental	/ɩn'kɒnsɩ ˌdɛntəl/
uze	/zɛt/
ekt	/ikɩt/
ine	/ɩnsi/
larfter	/'læfətɩə/
shool	/strul/
lepwerd	/lɛ'doʊəd/
gecken	/'ikwɛkən/
gisson	/gə'sun/
jisson	/dʒɑɩzən/
harjy	/'havi ˌdʒeɩ/
jynten	/'dʒɑɩˈntə/
codden	/goʊdən/
cuck	/kwɩ'ræk/, (quack)
harsy	/'ɑnsi/
kal	/krɑl/
kodden	/'koʊdənt/
kuzz	/'kjuzɩz/
sinten	/'sɛndən/
sylden	/'sɑɩdən/
elb	/ib/
oum	/juʌm/
ush	/juʃ/
ick	/drɩk/
dush	/dəsk/
tron	/raɩən/
sust	/ʃʊʃ/
tave	/loʊv/

Incorrect nonwords (continued)

substitution, addition or omission of word segments

exaggationers	/ɛkˈzædʒɜreɪʃ nɜz/
laborcolator	/ˈleɪbə kʌləreɪtə/
habinitation	/ˈri hæbɪteɪʃn/
cenectricities	/ kɒnisɛktrɪks/
gracontulation	/grænɪkjuleɪʃn/
forgivunable	/gɪvˈʌnkləbɒl/
cannistibalic	/ˈkæstibælɪnɪk/
dimeocrities	/daɪˈmɛnʃ nɜz/
imparsonious	/ ɪmprikjunɪɒs/
ramifationic	/ræmifæktʃərɜz/
algenerities	/ˈhæloɒ dʒɛnaɪtɪs/
logibiocally	/loɒˈbɪkjulə/

Phonemic realization of silent e

ize	/ɪzi/
efe	/ɛfi/

Failure of marking function of silent e

ume	/ʌm/

Addition of single grapheme/phoneme

oan	/oɒən/
akt	/ækæt/
jye	/dʒaɪn/
gye	/dʒaɪn/
cep	/kwɛp/
harsy	/hasli/
fep	/frɛp/
ish	/kɪʃ/
feep	/frip/
fush	/fjuʃ/
thip	/θrɪp/
fick	/frɪk/
dath	/dræθ/
sweal	/swidəl/

Omission of single grapheme/phoneme

electrifationic	/ɪlɛktrifætɒnɪk/
larnter	/læntə/

Incorrect nonwords (continued)

substitution of single grapheme/phoneme

Stimulus	Response
poom	/poɷm/
tround	/trænd/
wun	/wʌm/, (whoom)
drum	/kjum/
gonden	/goɷdən/
jasten	/dʒʌstən/
cinten	/sɩndən/
sym	/sɑɩm/
yeed	/jɛd/
shen	/sɛn/
bram	/breɩm/
bove	/loɷv/
coth	/kæθ/
troad	/trud/

Segmentation plus misconversion error

meap	/mijɒp/

Omissions

taum	"These are the awkward ones, you know"

I.C.

Reading Errors: Words

Visual
(these responses were made more quickly and confidently than were those classified as articulatory errors)

Stimulus	Response
truth	tooth pronounced /tɷθ/
origin	on
fate	fed
hint	mint
amount	mount
hospital	metal
slate	state
cult	cull
keg	leg
dell	bell
plant	plant
beggar	beginners*
battle	beadle
table	able
brother	bother
beat	peas
enjoy	annoy
deep	feet
on	no
problem	plod
go	do
come	some
arrive	five
due	do
big	pig
near	near
black	back
them	then

* only unequivocally visual error

Visual or semantic

number	sum

Derivational

ice	icy

Inflectional

happen	happened (2)

Stimulus	Response

Function word substitution

Stimulus	Response
he	his
whose	how
*up	off
who	you
hers	her

* visually and phonologically distinct from stimulus

Semantic

Stimulus	Response
machine	(/meι/, /meιʃ/) tool
shall	(shall I), shouldn't
bright	pert, (polite)

Errors resulting from articulatory difficulty

Stimulus	Response
average	/'ædədιdʒ/
attitude	/'ædədud/
topic	/tɒdək/
reminder	/ə'maιndə/
office	/'ɒdιs/
journal	/'dɜdəl/
oxygen	/'ɒndιdən/
angle	/ændəl/
cigar	/sə'nɑ/
landscape	/'lædde ιp/
gauge	/dʒeιdʒ/
laugh	/bæf/
break	bake
C sign	vine
mortgage	/'fɔ gιdʒ/
treat	/fit'/
sky	/saι/
lad	/pæg/
storm	/bɔm/
board	/blɔd/
person	/'tɜsən/
teacher	/'sitʃə/
opinion	/ɒ'pιnɒnɒn/
mast	/bæst/
dove	/bʌv/
skull	/sʌl/
spray	slay
kettle	/'ɛtəl/
lobster	/'lɒstə/
paper	/'peιbə/
time	/paιm/
moon	soon

Stimulus	Response

Errors resulting from articulatory difficulty (continued)

win	bin
been	/pin/
press	/pɛs/
bring	/bɩʒ/
went	bent
pray	pay
began	/bɩbæn/
narrow	/nædoɷ/
hot	/sɒt/
good	/bɷd/
big	pig
dark	/fak/
fresh	/fɛʃ/
busy	/ˈpɩzi/
against	/əˈbeɩnst/
along	/əˈlɒngd/
beside	/səˈnaɩd/
upon	/bɒn/
C them	pen
hand	/dænd/
shore	/dɔ/
number	/ˈlʌmbə/
teacher	/ˈsitʃə/
am	add
buy	vie
seem	seen
been	seen
press	/ɛs/
travel	/ˈkædəl/
attempt	/æˈtɛnt/
measure	/ˈvɛʒə/
low	/oɷ/
free	/si/
fresh	/wɛʃ/
heavy	/ˈɛdi/
narrow	harrow
below	/vəˈlo /
anybody	/ˈnɛdɩˌbɒdi/

Other

Incomplete responses

moment	/nə....mə/
method	/nɛd/
soul	/noɷ/
promise	/pəd/
	/pəv/
event	/ɛdə/
skin	/hə....nə/
distress	/sə....səd/

Incomplete responses (continued)

cost	/koɷ/
machine	/meι/
	/meιʃ/, (tool)
edition	/εb/
	/εbu/
iron	/sən/
wonder	/ənd/
natural	/mæl/
	/nə/
fifty	/fə/
husband	/dənd/
brother	/kə....nə/
thought	/θə....nə/
honour	/ədə/
control	("o","u"),/toɷl/
busy	/si/
young	/sə....nə/
pretty	/wət/
western	/εst/
English	/sə....nə/
behind	/də....də/

Completion

excuse	excuse me
shall	shall I (shouldn't)
you	you'd

Literation

control	"o", "u", (/toɷl/)

Perseveration

myself	pen

Unclassified

street	piece/peace
gift	/bəd/
sherry	/ˈad sʌn/
ink	/bιˈns/
between	/pˈεtud/
should	/ˈsowdιd/
battle	/ˈbændə/
warm	dawn
boy	eye
harp	/ˈhapɷd/
quest	/ˈkwɒdιd/
tempest	/ˈpεmtu/
bright	(pert), polite

Omissions

reason
democracy
musician
profile
due
thing
garden
bring
break
support
around
though

Reading Errors: Nonwords

Lexicalisations

Visually similar to stimulus

Stimulus	Response
owt	wood
oan	an
akt	ark
bon	ban
gue	glue
foo	for/four
bue	(blood), blue
sem	same
hoo	loo
ine	(/nə...də/, in, (on)

Visually distinct from stimulus

kie	sigh
bue	blood (blue)
ont	art
woz	what
ine	(/nə....də/, in, on

Incorrect nonwords

mun	/mæn/
iub	/ab/
hoz	/ɛs/

Stimulus	Response
Other	
Perseveration	
nue	do
Incomplete	
noo	/nə....nə/
ine	/nə....də/, (in, on)
Unclassified	
ekt	/a - də - tu/
kag	/æg - kɒd/
Omissions	
uze	

APPENDIX IV

THE POLISH ALPHABET

The Polish Alphabet

Letter		Name	IPA Transcription	Polish Phonetic Transcription
A	a	a	a	a
-	ą	ɔ̃	ɔ̃	ǫ
B	b	bɛ	b	b
C	c	t͡sɛ	t͡s	c
-	ch	tsɛ χa	χ	χ
-	cz	t͡ʃɛ	t͡ʃ	č
Ć	ć	t͡ɕɛ	t͡ɕ	ć
D	d	dɛ	d	d
-	dz	d͡zɛ	d͡z	ʒ
-	dź	d͡ʑɛ	d͡ʑ	ʒ́
-	dż	d͡ʒɛ	d͡ʒ	ǯ
E	e	ɛ	ɛ	e
-	ę	ɛ̃	ɛ̃	ę
F	f	ɛf	f	f
G	g	gɛ	g	g
H	h	χa	χ [ɣ]	χ [ɣ]
I	i	i	i	i
J	j	jɔt	j [i̯]	j
K	k	ka	k	k
L	l	ɛl	l	l
Ł	ł	ɛw	w [u̯]	ł
M	m	ɛm	m	m
N	n	ɛn	n	n
-	ń	ɛɲ	ɲ	ń
O	o	ɔ	ɔ	o
Ó	ó	ɔ krɛskɔvanɛ	u	u
P	p	pɛ	p	p
R	r	ɛr	r	r
-	rz	ɛr zɛt	ʒ [ʃ]	ž [š]
S	s	ɛs	s	s
-	sz	ʃa [ɛʃ]	ʃ	š
-	ś	ɛɕ	ɕ	ś
T	t	tɛ	t	t
U	u	u	u	u
W	w	vu	v	v
Y	y	ɨpsɨlɔn [i grɛk]	ɨ	y
Z	z	zɛt	z	z
Ź	ź	ʑɛt [zɛt s krɛskɔ̃]	ʑ	ź
				ž

APPENDIX V

RESPONSES TO TEST ITEMS NOT INCLUDED IN THE ERROR CORPORA

APPENDIX V

Responses to test stems not included in the error corpora

Responses to items in the Auditory Sound Blending and Repetition Tests are listed in this Appendix. Also listed are reading responses to certain tests of nonword processing. These responses were not included in the error corpora because it was felt that certain test stimuli might elicit lexicalisation errors because of their particular construction and hence distort the pattern of errors made by each patient. In the Reading by Analogy Tests failure to delete a ringed letter would lead to a real-word response. Inappropriately suffixed words and affixes in isolation are both formed from morphemic units of the English language and again might tend to elicit real-word responses.

The symbol + indicates a correct response and the symbol - an omission.

Tests contained in this Appendix are listed below:

Nonword processing

1. Nonwords synthensised from words.
2. Sound Blending I
3. Sound Blending II
4. Reading by analogy I

5. Reading by analogy II

6. Inappropriately suffixed nonwords.

7. Affixes in isolation.

Repetition ability

8. Pseudohomophony I

9. Easy Lexical Decision.

10. Nonwords of different structure.

1. Nonwords synthesised from words

With colour cue

Stimulus	DA	DP	TW	CB
		Response		
tugant	and, no	+	tug ant	tugant, /tə'gænt/
attype	at	type	+	at, type +
fistam	fit	fist	/'fɩtsæm/	fist, am, /'fɩstænt/
topain	pain and she, no	pain	+	to pain, +
pother	pat, no	potato	+	pot her, +
hispat	he, no, she	+	/hɜpæt/	hiss pat
hatein	-	-	hate in	hate him
biteto	bite it	-	to Biro, to bite	bite do, bite to
pigham	ham	+	+	pig ham, /'pɩgəm/
nothat	hat and not	+	no hat	not hat, +

Without colour cue

Stimulus	DA	DP	TW	CB
		Response		
tugant	-	tug it	tangerine, no	/'təgə/,+
attype	-	attic	type, /'ʌpətaɩp/	a type
fistam	-	first	fistfight	fizz arm
topain	-	pain	tee pain,+	to paint
pother	-	bother	the brother	potter
hispat,	he, no	hips	/'ɒksipæt/, hospital	hiss pan, +
hatein	hat	-	-	hating
biteto	biting	-	Biro	bite Ted
pigham	ham, no	+	pig	pig ham
nothat	hat	-	no tact, no pat	no than, nothing

1. Nonwords synthesised from words (continued)

With colour cue

Stimulus	Response: JS	ZS	PG	WPB
tugant	+	/'tʌgən/	tug ant	/tʌg'rænt/
attype	at sight	a tip	+	+
fistam	fist ham	fist	+	+
topain	to pain	to pain	+	+
pother	/sɒt/ her	pot her	potter	+
hispat	+	spit	+	+
hatein	hate in	hate	+	/'eɪtɪn/
biteto	bite to	bite	bite through	bite /u/
pigham	pig ham	+	+	+
nothat	not hat, not high	not hat	+	+

Without colour cue

Stimulus	Reponse: JS	ZS	PG	WPB
tugant	/tudænt/	/'tʌgə/	/tʌgæn/	tug ant
attype	a sight	alter	+	/'æltaɪp/
fistam	+	+	/'fɪtæm/	fist, +
topain	+	paint	+	/toopeɪnt/
pother	/'pɒltə/	bother	potter	/pɒthoo/
hispat	+	/hɪntə/	+	+
hatein	+	hated	+ (/hæteɪn/)	/heɪtiən/
biteto	my to	bitter	/'baɪtæm/	/'baɪltu/
pigham	pig ham, +	/'pɪgənt/	+	/'pɪgræm/
nothat	not that	not that	+	/'nɔθæt/

2. Sound Blending I

Stimulus	DA	DP	TW	CB
		Response		
f - oot	+	+	-	+
m - an	+	+	and	+
sh - oe	-	+	-	+
c - ap	-	+	-	+
c - ar	-	+	-	+
c - up	-	+	-	+
sh - i - p	-	+	+	+
ea - t	+	-	+	+
e - gg	+	+	+	+
u - p	+	-	+	+
c - ow	-	+	-	+
m - e	-	+	+	+
f - i - sh	foolish	+	+	+
c - a - t	+	+	+	+
b - i - g	-	+	+	+
s - a - d	+	+	act	+
b - oa - t	boot	+	+	+
n - o - se	+	no	-	+
d - i - nn -er	-	dish	-	/noosə/
f - ea - th - er	-	-	forget	feet, no light
l - i - tt - le	-	+	-	-
k - e - tch - u - p	get up	+	+	+
b - a - b - ie - s	behave	baby	-	-
t-e-l-e-ph-o-n-e	+	-	-	let, no fee
/l - ɛ - k/	-	-	egg, age	-
/eι - f - i/	lay	+	/eιji/	-
/v - ʌ - m/	-	+	forgets	-
/r - æ - s - t/	rats	+	-	-
/t - i - k - oo/	/t ki - hoo/	-	-	-
/t - ɑ - p - ι - k/	-	-	-	-
/r - ʌ - s - oo - p/	-	-	-	
/oo-p-æ-s-t-oo/	-	-	-	

2. Sound Blending I (continued)

Stimulus	JS	ZS	PG	WPB
	Response			
f - oot	+	-	+	-
m - an	and	+	mad	-
sh - oe	+	-	+	-
c - ap	+	+	+	+
c - ar	tar	+	+	cup
c - up	/kə-ʌp/	up	cot	-
sh - i - p	+	+	+	+
ea - t	+	+	+	-
e - gg	+	+	+	egging
u - p	+	+	+	-
c - ow	owl	-	owl	call
m - e	meet	+	keel	machine
f - i - sh	bitch	-	ship	-
c - a - t	+	+	+	-
b - i - g	+	+	dog	budgerigar
s - a - d	-	at	sat	÷
b - oa - t	+	-	+	-
n - o - se	+	-	+	known
d - i - nn - er	dropping	-	-	-
f - ea - th - er	fester	-	fairly	-
l - i - tt - le	/ɩtɑlijə/	-	-	umbrella
k - e - tch - u - p	-	-	+	-
b - a - b - ie - s	-	-	+	-
t-e-l-e-ph-o-ne	-	-	+	-
/l - ɛ - k/	/ˈɩzɛ̆k/	lever	egg, lay	next
/eɩ - f - i/	-	age	/eɩf/	have
/v - ʌ - m/	-	-	every	name
/r - æ - s - t/	-	-	/rɛft/	-
/t - i - k - ꝏ/	-	-	-	tuxedo
/t - ɑ - p - ɩ - k/	-	-	-	-
/r - ʌ - s - ꝏ - p/	-	-	-	-
/ꝏp-æ-s-t-ꝏ/	-	-	-	-

3. Sound Blending II

(see list in Chapter 3 for phonetic transcription)

Stimulus	DA	DP	TW	CB
		Response		
ea - d	+	-	Eden	-
ea - p	+	+	-	+
n - oo	+	+	+	-
oi - d	-	+	+	+
ai - f	+	-	/æfə/	-
e - th	+	to	/ɛtə/	-
u - sh	+	+	+	/ʃ/
u - th	-	us	-	-
e - ck	+	+	+	-
a - th	-	as	-	/æ/, the
t - a - d	-	+	cad	+
d - o - d	/d-ɒ-d/dog	+	dog	+
n - u - d	nod	+	-	nod
l - a - l	-	-	till	/leɩl/
m - u - b	-	+	bird	-
a - n - k	-	sea	-	-
i - p - t	/ɩ- p - t/	-	-	chapped
a - l - b	-	+	-	-
e - l - t	+	-	-	-
i - s - p	-	+	-	-
t - oo - d	+	+	-	+
d - oa - d	road	+	-	+
n - au - d	-	+	-	node
l - ai - l	-	-	-	ladle
m - au - t	-	+	-	-
d - a - ck	-	+	acting	+
f - u - sh	-	fuss	shoe	few, fund
sh - a - p	-	+	-	she, /æp/
th - u - t	-	/θ/	-	the
n - a - th	-	/næs/	-	-
d - u - n - t	-	Dan	-	-
h - a - n - t	-	/hæ/	-	-
d - r - a - p	tramp	+	-	rap
b - r - a - m	-	-	-	/bə/
			-	/gə/

3. <u>Sound Blending II (continued)</u>

(see list in Chapter 3 for phonetic transcriptions)

Stimulus	Response: JS	ZS	PG	WPB
ea – d	eaten	+	+	+
ea – p	+	+	up	+
n – oo	+	/nɛp/	now	noon
oi – d	–	–	/oɪ – ɒd/	+
ai – f	+	age	+	+
e – th	+	/ɛstə/	/ɛgθ/	+
u – sh	she	+	+	ushered
u – th	+	us	us	+
e – ck	+	+	+	+
a – th	+	ash	as	+
t – a – d	to hands	+	timed, tend	add
d – o – d	/də/, hard	dog	bod	doctor
n – u – d	–	–	/nʌb/	inactive
l – a – l	–	/lɪl/	–	+
m – u – b	–	rubber	/mɜb/	small
a – n – k	–	ant	and	anchor
i – p – t	–	–	zip	hip, den
a – l – b	–	–	–	–
e – l – t	–	–	–	/ɛˈθɛlkə/
i – s – p	–	/ɪst/	zɪp	+
t – oo – d	+	too	too	+
d – oa – d	–	goat	/dɜ/	/di/, odour
n – au – d	–	gnaw	/nʌd/	in, order
l – ai – l	–	–	lay	+
m – au – t	–	–	/mʌt/	motor
d – a – ck	+	Jack	dab	+
f – u – sh	–	fuss	/fə/	ash
sh – a – p	+	–	/ʃə/	+
th – u – t	–	–	–	+
n – a – th	–	–	–	–
d – u – n – t	–	dump	–	–
h – a – n – t	–	–	have	–
d – r – a – p	–	–	–	–
b – r – a – m	–	/bæm/	/bə/	–

Reading by Analogy I: Deletion

Note: Where test item was not originally read correctly, it was excluded from the test set.

Stimulus	DA	Response DP	TW	CB
drink	-	ink,brink	drank	+
doctor	-	/'bɒktə/	docked,no	+
lake	-	fake	-	/ k/
dress	-	Bess	dressed	+
boy	-	/fɔɩ/	-	+
bird	-	furred	-	+
hand	-	-	-	+
spring	-	/'sprɩŋɩn/	-	ping
street	-	feet	-	+
bed	-	stead	bedded	+
star	-	tar	start	+
home	-	home	-	+
train	-	rain,fain	-	+
bag	-	+	baggage	+
milk	-	mild,/mɩd/	middle	mink
box	-	bee	-	/bu/
earth	-	+	-	/æθ/
fail	-	fall	-	+
foot	-	shoe,foot	football	+
door	-	/də/,stew	/'duə/	+
farm	-	+	farm	+
book	-	/buk/	/buk/	/buk/, /bɒ - ʌk/
wound	-	/wɩnd/	excluded	/wɒnd/
salt	/sə/, salt	/sə/	-	/sɒl/
child	-	/'gaɩəld/	-	+
branch	-	brand	-	/bræn - kə/
chair	-	fair	-	+
woman	-	woe	-	/wə/, /wɒmp/
girl	-	whirl,furl	-	+
river	-	/r v/	fiver	reeve
class	-	/kæst/, +	ass	+
uncle	-	/'ʌntəl/	/'ʌnɩkəl/	/ʌnk - i/
bowl	-	/oɒl/, +	-	+
family	-	/fæm/	-	/fæ - ɩli/
moon	-	monk	man	moan

Reading by Analogy I: Deletion (continued)

Stimulus	JS	ZS	FW	WPB
		Response		
drink	excluded	/'drɩŋkd/	+	brink
doctor	+	doctor	+	+
lake	excluded	-	/keɩ/	+
dress	dresses	dressed	+	/rɛs/
boy	high	-	+	+
bird	beer	burn	+	+
hand	+	-	/nə/, /ɛn/	band
spring	excluded	-	spins	bring
street	/rit/	street	+	/rit/
bed	head	bread	+	wed
star	+	straw	stan,stack	+
home	+	home	+	home
train	train	/ʌn - teɩn/	+	rain
bag	+	bag	a bag/bɑ/	+
milk	milk	-	mink	/milk /
box	box,who	/bɒks - t/	+	cox
earth	/ɜt/	-	+	earth, /r /
fall	excluded	-	+	+
foot	fat	feet	/fɒk/	foot
door	door	door	+	raw
farm	farm	famous	+	+
book	book	-	+	cook
wound	excluded	excluded	/wund/, /waɷnd/	+
salt	+	salt	soft, +	+
child	chilled	/tʃaɩldz/	/tʃaɩənt/, chide,chill, chilly	/tʃɩldə/
branch	excluded	branch	/stra/,/bra/	/bræntʃ/
chair	car	chair	stay,clay clear	chain
woman	/w m-æn/	-	+	/u - mæn/
girl	girl	-	+	+
river	river	-	/rɩv -i/, /rɛv/,river	+
class	ass	case	(Type A) glass,+	lass
uncle	/" nd l/	-	+ /bul/	/ nk / + [illegible]

Reading by Analogy II: Substitution

Stimulus	Response DA	DP	TW	CB
p, bag	+	tag	+	/pæŋ/
p, bed	/pə/,/pə/	fed	-	+
p, bid	-	bid	pig	+
p, boy	-	roy	-	+
v, fill	+	excluded	-	veal
v, food	+	-	-	+
g, King	+	Kings	girl	+
b, past	-	+	+	baste
b, peal	-	+	deal	peal, no
b, pick	-	brick	+	+
b, pine	-	+	bin	+
b, plan	-	excluded	ban	+
d, take	-	bake	takeaway, no	+
s, zoo	+	duke, /sə/	+	+
z, bag	/'sɪsə/	-	/zɛd/, no	sag
z, bed	sit	/ɛd/	zoo	+
f, bid	+	+	-	+
f, boy	fish,no	+	+	+
l, fill	+	excluded	-	-
p, food	-	food	-	+
j, King	-	king	-	/dʒɪŋk/
n, past	-	+	+	+
j, peal	-	+	-	jail
j, pick	Vick	prick	key	/dʒɪŋk/
r, pine	-	fine	/raɪv/	+
v, plan	-	excluded	-	/blæn/
v, take	/vud/	fake	'	/væk/
j, zoo	-	/dʒə/	/dʒəɪ/	+

		Response		
Stimulus	JS	ZS	PW	WPB
p, bag	excluded	bag	Pam	buy
p, bed	+	bread	/pɛl/, pad	+
p, bid	pick	peek	pill, /pɪd/,+	+
p, boy	+	a boy	Pa	+
v, fill	bill	excluded	+	Jill
v, food	+	wood	/vɛld/, value	/dʒud/
g, King	/dɪŋ/	/grɪŋ/	+	ring
b, past	excluded	/blæst/	+	/bræst/
b, peal	excluded	pealing	+	+
b, pick	+	brick	big	/bɜk/
b, pine	bind	'	/pim/	+
b, plan	excluded	-	bang	/bæm/,/bræm/
d, take	+	sake	make	drake
s, zoo	+	zoo	+	+
z, bag	excluded	hag	/zɛd/,/žæg/	/zəbæg/
z, bed	dead	sled	+	/d d/
f, bid	fit	/brɪd/	/fɪp/	+
f, boy	+	/frɔɪ/	for	+
l, fill	+	excluded	+	sill
p, food	food	proved	pier	prude
j, king	+	king	+	+
n, past	excluded	nasty	+	+
j, peal	excluded	jeep	+	+
j, pick	/dʒɪt/	-	+	/fɪk/
r, pine	+	-	fine	+
v, plan	excluded	-	van	/væm/
v, take	/'məreɪk/	-	+	+
j, zoo	+	zoo	gin, +	+

Inappropriately suffixed words

Stimulus	Response: DA	DP	TW	CB	JS
firster	–	first	fresher	first /tə/, /rə/	+
problemer	–	+	problems	/'prɒbləmi/	+
dogest	doggy	+	digest	/'dɒgɩd/	/'dɒdɛst/
gardenest	flower	gardening	garaged	gardening	+
husbandest	husband	+	husbanded	husband dear	+
mouthest	–	+	mouthed	mouthing/, /maʊθtɩŋ/	+
darking	–	darken	darken	darkening	+
freshing	–	refreshing	+	freshening	+
daying	–	saying	dying	+	+
thinging	–	/θɩŋɛst/	thinking	thing,/gɩŋ/	+
colded	–	cold	collided	colder	+
sweeted	sweets	sweetened	sweetened	/'switɩŋ/	+
brighted	light	brightest	brightened	brighten, "t", "d"	+
deeped	–	deep,	deed	deepen, /də/	/dip -ɛd/
coatly	–	/koʊstli/	closely	/'koʊtlɩŋ/	/'oʊtli/
helply	–	helpless	happy, but no	help, apply	+
bringly	–	/brɩŋəst/	brightly	+	+
happenly	–	happening	happily	happy	+
followly	–	following	follow	following	/fɒloʊ- li/
beatly	–	beast	beauty	+	+
speakest	–	speaking	speech	speaking	/spik -ɛst/
explainest	–	+	explained	explaining, no nest	+
supportest	–	supporting	supported	supporting, no, / st/	/oʊ'sʌpɛst/
enjoyest	–	/ə'nɔɩɛst/	enjoyable	enjoying,no	+
wantest	–	+	wanted	wanting, / st/	+

Inappropriately suffixed words (continued)

Stimulus	ZS	PG	Response FW	WPB
firster	freshest	+	/fɛst/, /θɛst/, /fɛst-ɒv/, /'fəzi/	/fɩstə/
problemer	problem	+	/'prɒpɒzɩʃɷnə/ /probləm-ɜ/	problem
dogest	/'dɔdʒɛst/	+	/d'ɒgəzi/	+
gardenest	/'gɑdɛnt/	+	/'gɑdənɜrɛst/	+
husbandest	/'hɑzbɩnɛst/	+	/hʌzbɒn'dɛs/	+
mouthest	+	+	+	+
darking	barking	+	darky, +	/dɑklɩŋ/
freshing	/'frɛʃtɩŋ /	+	+	+
daying	dying	+	+	+
thinging	thinking	+	+	+
colded	cool it	cooled	/'kooldəz/	colder
sweeted	Sweetex	+	+	+
brighted	biggest	+	+	brightened
deeped	digest, /daɩ'bɛt/	deepest	/dip -ɛd/	+
coatly	/'gɒtli/	+	/kool - li/	+
helply	+	+	+	+
bringly	+	+	bring he	+
happenly	happily	happily	/hæpɩŋli/	+
followly	follow, followed	+	+	+
beatly	+	+	beat, +	+
speakest	+	/spitʃ-dɛst/	+	+
explainest	/ɛk'spleɩnɛ ts/	+	/ɛksplə'neɩ ʃɷnɛst/	+
supportest	supported	+	/'sʌpɒs/, /'sʌpɒd/, /'sʌpədi/	+
enjoyest	+	+	/dʒɔɩnɛst/,+	+
wantest	wanted	+	+	+

Affixes in isolation

Stimulus	DA	DP	TW	CB
ly	-	-	-	by
ably	able	alley	able	able, "y"
ed	-	-	end	it, no, "d"
ing	-	+	+	+
ment	me	comment	comment	+
un	you	under	likely, no unlikely	+
ness	-	mess	mess	+
er	you	-	-	"e", "r"
ous	-	house	-	"o", "u", "s"
en	-	-	harden	+

Stimulus	JS	ZS	PG	WPB
ly	lay	-	+	/baɩb/
ably	+	able	+	/e bi/
ed	+	end	+	/id/
ing	+	in	+	+
ment	+	-	+	+
un	+	-	+	+
ness	+	+	+	+
er	+	-	+	+
ous	/ s/	-	ooze	/dɩks/
en	+	-	+	+

Repetition of Pseudohomophony I

Stimulus Word	DA	DP	TW	CB	JS
one	+	+	+	+	/wɒn/
use	+	+	+	youth	+
was	+	+	+	+	+
out	+	+	+	+	+
wore	+	were	+	+	+
buy	+	+	+	+	+
who	+	+	+	+	+
few	feud	+	+	+	+
own	owed	+	owned	+	+
act	at	+	+	+	+
do	+	+	+	+	+
new	news	+	+	+	+
can	cad	+	+	+	+
said	+	+	+	+	+
eyes	+	+	+	+	+

Nonword	DA	DP	TW	CB	JS
/bɒn/	bond	+	+	+	+
/mʌn/	+	+	+	+	+
/gu/	queue	glue	+	+	/ju/
/ɔɩn/	oil	+	+	+	+
/fu/	food	+	+	+	+
/kɑz/	+	+	sky	+	+
/hɒz	+	+	+	+	+
/ɛkt/	+	egg	+	+	+
/bju/	/bjud/	+	+	+	+
/kæg/	cad	+	+	+	+
/sɛm/	+	+	+	+	+
/ɒnt/	+	+	+	+	+
/nu/	+	+	+	+	+
/aɩn/	+	+	+	+	+
/jum/	+	+	+	+	+

Repetition of Pseudohomophony I (continued)

Stimulus	Response			
Word	ZS	PG	FW	WPB
one	+	+	+	+
use	you	+	+	+
was	what	+	+	+
out	+	+	+	+
wore	+	+	+	wall
vyt	+	+	+	+
who	+	+	+	+
few	+	+	+	+
own	+	owe	+	+
act	at	+	+	+
do	/gu/	+	+	+
new	+	+	+	+
can	+	+	+	+
said	/zɛt/	+	+	deb
eyes	/aɪji/	eye	+	/aɪn/

Nonword	ZS	PG	FW	WPB
/bɒn/	+	bond	+	+
/mʌn/	+	+	+	+
/gu/	+	+	+	+
/ɔɪn/	+	+	+	owing
/fu/	+	+	+	+
/kaɪ/	+	+	+	+
/hɒz/	/hɔɪ/	+	+	+
/ɛkt/	/ɛks/	+	/ɛk/	/ɛk/
/bju/	+	+	+	new
/kæg/	cat,/kæɪji/	cad	+	+
/sɛm/	+	+	+	+
/ɒnt/	+	/ɒnk/	+	+
/nu/	+	+	+	+
/aɪm/	+	+	+	am
/jum/	+	+	+	+

Note: IC's responses to this test are included in Case Report X.

Repetition of Easy Lexical Decision

Stimulus Word	DA	DP	TW	CB	JS
	Response				
house	+	+	+	+	+
hand	+	+	+	+	+
money	+	+	+	+	+
street	+	+	+	+	/srit/
room	+	+	+	+	+
school	+	+	+	+	+
fire	+	+	+	+	+
woman	+	+	+	+	+
church	+	+	+	+	/tʃatʃ/
floor	+	+	+	+	+
head	+	+	+	+	+
eye	+	+	+	+	+
car	+	+	+	+	+
book	+	+	+	+	+
city	sit	sitting	+	+	+
boy	+	+	+	+	+
road	+	+	+	+	+
table	+	+	+	+	+
man	+	+	+	+	+
child	+	+	+	+	+
door	+	+	+	+	+
girl	+	+	+	+	+
face	fate	+	+	+	+
water	+	+	+	+	+
food	+	+	+	+	+

Repetition of Easy Lexical Decision (continued)

Stimulus	ZS	PG	Response FW	WPB
Word				
house	+	+	+	+
hand	+	how	+	+
money	+	+	+	+
street	+	+	/strip/	+
room	+	+	+	+
school	+	+	+	+
fire	+	+	+	+
woman	+	+	+	+
church	+	+	+	+
floor	+	+	+	+
head	+	+	+	+
eye	+	+	+	+
car	+	+	+	+
book	+	+	+	+
city	+	+	+	+
boy	+	+	+	+
road	+	+	+	+
table	+	+	+	+
man	+	+	+	+
child	+	+	+	+
door	+	+	+	+
girl	+	+	+	+
face	+	faith	+	+
water	+	+	+	+
food	+	+	+	+

Repetition of Easy Lexical Decision (continued)

	Response				
Stimulus	DA	DP	TW	CB	JS
/bɛm/	+	+	+	+	+
/wælp/	walk	+	+	+	+
/krɪdʒ/	bridge	cringe	crib	+	+
/dɔd/	+	+	+	+	door
/kʌn/	+	+	+	+	+
/'pasi/	parsley	+	+	+	+
/keɪb/	+	+	+	+	+
/pleɪf/	+	play	play	+	+
/gɒg/	+	+	+	+	+
/bɔlt/	+	+	+	bulk	+
/pɪvə/	+	+	+	+	+
/koʊ/	+	+	+	+	+
/skweɪt/	+	+	+	+	+
/baɪf/	+	+	+	+	+
/daɪt/	+	+	+	+	+
/moʊm/	+	+	+	+	mown
/heɪpə/	paper	+	+	+	+
/pum/	+	+	+	+	+
/noʊt/	+	+	+	+	nose
/reɪm/	+	+	+	+	+
/traʊnd/	town	round	+	+	+
/steɪp/	+	+	+	+	+
/kaʊn/	+	+	+	+	+
/fal/	+	+	+	+	+
/klʌt/	+	+	+	+	+

Repetition of Easy Lexical Decision (continued)

Stimulus	ZS	PG	FW	WPB
			Response	
/bɛm/	+	bent	+	+
/wælp/	+	wood	+	wallop
/krɪdʒ/	+	+	+	+
/dɔd/	George	doors	/dɔt/	+
/kʌn/	+	+	+	+
/'pasi/	+	+	+	/'pazi/
/keɪb/	+	+	+	+
/pleɪf/	+	+	+	+
/gɒg/	+	golf	+	+
/bɔlt/	+	/bælk/	+	+
/pɪvə/	+	+	+	+
/koʊ/	+	+	+	+
/skweɪt/	+	+	skate	+
/bɑɪf/	+	+	+	+
/dɑɪt/	+	dyke	+	+
/moʊm/	+	+	+	+
/heɪpə/	+	+	+	+
/pum/	+	+	+	+
/noʊt/	+	+	+	+
reɪm/	+	+	+	+
/traʊnd/	town	+	round	+
/steɪp/	+	+	+	+
/kɑʊn/	+	cowed	+	+
/fɑl/	+	+	+	+
/klʌt/	+	+	+	+

Repetition of nonwords of different structure

Stimulus	DA	DP	TW	CB	JS	ZS	PG	WPB
				Response				
Type A								
/tæd/	+	+	+	+	+	/tæt/	+	+
/dɒd/	dog	+	+	+	dog	+	dog	+
/nʌd/	+	+	+	+	+	+	+	+
/læl/	+	+	+	+	+	light	+	now
/mʌb/	+	+	mum	+	+	+	mud	mob
/jɛd/	/ɛd/	+	+	+	/jɛp/	+	+	+
/sɒm/	sum	+	+	+	+	+	+	+
/mɛp/	+	+	+	+	+	+	+	+
/fɛp/	+	+	+	+	+	fed	+	+
/sæb/	+	+	+	+	+	+	+	+
Type B								
/æŋk/	and	+	+	+	+	+	+	ant
/ pt/	–	+	+	it	+	+	+	+
/ælb/	+	+	+	+	+	/ælbi/	/æb/	+
/ɛlt/	+	+	+	+	let	+	+	elk
/ɪsp/	+	+	+	+	+	/ɪs/	+	+
/ʌld/	old	+	old	+	+	/ʌl/	up	old
/ɒnt/	+	+	+	+	+	+	+	+
/ɪnd/	+	+	in	+	+	+	+	+
/ɛsk/	+	+	+	+	+	+	+	+
/ɛmp/	+	+	+	+	+	+	+	+
Type C								
/id/	+	feed	+	+	+	+	+	+
/ip/	+	+	+	+	+	+	+	+
/nu/	nude	+	+	+	+	/nut/	+	new
/ɔɪd/	+	+	+	+	+	oiled	oil	+
/eɪf/	/eɪvə/	+	+	+	+	+	+	+
/voʊ/	vase,no	+	+	+	+	roe	+	+
/ɑʊm/	+	+	+	+	/oʊm/	+	+	/eɪm/
/oʊb/	+	/oʊg/	+	+	+	+	/oʊp/	+
/im/	+	+	+	+	+	+	+	+
/ɔm/	+	+	all	+	+	all	+	+

Repetition of nonwords of different structure (continued)

Stimulus	DA	DP	JW	CB	JS	ZS	PG	WPB
	Response							
Type D								
/εθ/	/εs/	/εʃ/	+	+	+	+/εt/	/εnθ/	+
/ʌʃ/	+	us	+	+	+	/ʌtʃ/	+	+
/ʌθ/	–	+	+	+	us	+/ʌt/	+	up
/εk/	+	+	+	+	+	+	+	+
/æθ/	+	+	+	+	+	+/æt/	as	/æk/
/ɩθ/	is	if	+	+	+	is	+	+
/ɩʃ/	+	+	+	+	+	/ɩs/	+	+
/εʃ/	she,no	+	+	+	+	+	+	+
/ɒʃ/	+	+	+	+	+	+	+	+
/ɩk/	+	+	+	+	+	+	+	+
Type E								
/tud/	toad	+	+	+	+	+	+	+
/doʊdʒ/	+	+	+	+	/doʊb/	dough	+	+
/nɔd/	/nə/	+	+	+	/nɔn/	+	+	nude
/leɩl/	+	+	+	+	+	+	+	+
/mɔt/	malt	+	+	+	+	maul	+	+
/jid/	+	+	+	+	+	+	+	knead
/soʊm/	+	+	+	+	+	some	+	dome
/mip/	+	+	+	+	+	+	mean	+
/fip/	+	+	+	+	+	+	+	+
/kik/	keep	+	+	+	+	+	+	+
Type F								
/dæk/	+	+	+	+	+	+	+	+
/fʌʃ/	+	+	+	+	+	fuss	+	+
/fæp/	+	+	+	+	+	+	+	+
/θʌt/	thus	+	+	/θʌp/,/θʌk/	thus	/hʌst/	thus	sup
/næθ/	+	+	+	+	+	+/næt/	+	+
/hʌk/	+	+	+	+	+	+	+	+
/ʃʌm/	+	+	+	+	+	+	+	+
/ʃεn/	+	+	+	+	+	+	+	+
/θɩp/	+	thing	+	+	+	+/tɩp/	this	+
/pɒθ/	+	+	+	+	+	+/pɒt/	+	+

Repetition of nonwords of different structure (continued)

Stimulus	DA	DP	TW	CB	JS	ZS	PG	WPB
				Response				
Type G								
/dʌnt/	+	+	+	+	+	duck	do	done
/hænt/	+	+	/hæn/	+	+	+	ant	+
/dræp/	+	+	+	+	/dræst/	+	+	+
/bræm/	+	+	+	+	+	+	bran	ban
/dænd/	/dæŋ/	+	+	+	band	+	/dræn/	stand
/træb/	grab	+	+	+	+	+	+	+
/træt/	+	+	+	+	+	+	+	/dræt/
/jɛlt/	+	+	+	+	+	+	+	+
ɲnɒld/	+	+	+	+	+	+	nod	+
/trɩn/	+	+	+	+	+	+	+	+

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